5. Brickwork

A. I. A. Standard Classification

Brick

How to Build and Estimate

BRICK

HOW TO BUILD AND ESTIMATE

A manual of construction data on brickwork for architects, engineers, contractors and builders; and for class use in educational institutions and manual training schools. A presentation also of some vital facts for prospective owners of houses and other buildings. Of interest to all desiring authoritative information on brickwork and its accessories

BY WILLIAM CARVER
ARCHITECT

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78 ILLUSTRATIONS 12 PLATES 31 TABLES

The Common Brick Manufacturers' Association of America

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FOREWORD

IN every building operation, even in the erection of a low-priced house, it is desirable to consult an architect or engineer. In designing and planning; in fitting a building to its environment; in the specification and inspection of materials, the training and experience of a professional man is of value to every builder.

The purpose of this book is to give dependable information upon the use of brick and to afford a basis of co-operation between owner, architect and contractor in accomplishing first-class results in brick construction.

There unquestionably exists throughout the United States a preference for brick construction. Brick is a native, natural material, and its manufacture is a local enterprise in almost every section of the country. In the erection of apartments, schools, hospitals, store buildings and industrial buildings this preference finds expression in enduring brick structures. In the building of the homes of America, however, brick is not the prevailing material in spite of the national preference for it.

The reason for this is an exaggerated and wholly unfounded belief that the brick home is expensive. The first cost difference between brick and the cheapest form of construction in the home of the average man—a five or six-room cottage or bungalow—in no part of the United States amounts to more than two to four hundred dollars.

Because brick has not been more largely used in residence construction, there is throughout the country a scarcity of mason contractors specializing in home building. A contractor schooled in another type of construction is not usually equipped to give a just estimate upon the cost of the brick home. It is a case of "every man to his trade."

This volume is intended to serve as an aid and a reliable manual of information for the builder who wishes to enlarge his field of operation and meet the growing demand for more substantial buildings. The builder who cannot safely estimate and build in brick will find himself more and more at a disadvantage. The alarming waste of timber and a certain lumber shortage not far away, coupled with a national spirit of conservation which will be expressed in the greater use of more lasting construction materials, is certain to result in increasing the demand for permanent fire-resistive buildings, even down to the most modest priced homes. The architect, builder, the realtor-builder and the contractor may, if he studies this book, find himself better equipped to meet changing conditions.

Courtesy Architectural Record.

Detail of Garden Front —
House at Greenwich, Conn.
John Russell Pope, Architect.

BRICK CONSTRUCTION ECONOMICAL AND EVERLASTING

USEFUL MATERIAL HAS MANY ADVANTAGES

Investing in a House:

1. To most people the building or buying of a house is an investment of the first magnitude. Very frequently a man's entire lifelong savings are represented in his home, and in case of sickness or misfortune his ability to raise money will depend entirely upon its selling or loanable value. A man should set about acquiring a house with as much care as he used when he picked his wife.

2. The wise man will ask "Will my investment, represented by my house, yield a fair return? How much will its value decrease, year by year, through wear and tear? What will be the cost of its upkeep? If I ever have to sell it, how much will it be worth? If I ever have to raise money, how much could I borrow on it?" He will also ask "Is it going to be comfortable to live in? What are the chances of it burning up and burning me out?"

3. These are all pertinent questions, and the answer to every one of them depends upon the answer to another question, "Of what material will your house be built?"

Brick and the Pocketbook:

4. Brick has many claims to the attention of every class of prospective builder, and the first and strongest of these claims is **economy.**

5. Though the most distinguished of all the building materials, brick saves dollars and cents to the man who intends to be his own tenant, or who is building as a means of providing an income, or who is a renter; and makes a bigger profit possible for those who build to sell.

Beautiful, Yet Economical:

6. Brick is one of the most beautiful of building materials, and one in which all kinds of architectural designs may be easily conceived and carried out. Those who have traveled in the old world probably remember the charming houses and villages of brick, centuries old, which seem only to grow more mellow under the hand of time.

Ancient Examples:

7. The illustration on the next page shows how brick homes endure. This house, built in England in 1699, in continuous occupation since erected and occupied now, is as substantial, in as good repair and even more beautiful than when built, although it has weathered the storms of over three centuries.

8. Even in this country we may point with satisfaction to landmarks such as Independence Hall, built of brick in 1729 and still in perfect condition. Another brick structure is the little house in which Betsy Ross made the first American flag. Then there is the famous old state house of Boston, Faneuil Hall; the tiny home of William Penn; the many brick inns of the Jersey and Pennsylvania early settlements; the stately and charming old brick houses of Virginia and a host of others too numerous to mention. The men who built these old brick buildings were wise enough to realize, even in their day, the advantages of brick construction.

Brick, the Everlasting Surface:

9. The slogan "Save the surface and you save all," advertised extensively to sell excellent but expensive paint, does not interest the builder in brick. He doesn't have to spend a cent in order to "save the surface." He got an everlasting surface when he bought his brick.

Depreciation:

10. As the years pass, brick does not get that ancient, weatherbeaten look. Age bites at brick vainly.

11. Statistics show that brick buildings depreciate more slowly than any other class of construction. To be exact, a brick house does not depreciate at all during the first five years after it is built, and after that at the rate of only 1% per year. As a comparison frame buildings depreciate 3% per year, beginning as soon as built. These figures are given on the authority of John J. Thomas, of the Lloyd-Thomas Company, Chicago, prominent appraisal engineers; and are taken as a basis of assessment in a great number of cities.

12. Take a typical example,—a brick house costing $6,000 and a frame house costing the same amount. In ten years the frame house will have decreased in value to $4,200; the brick house to $5,700. This is, of course, regardless of the value of the lot and changed values due to other causes.

Brick, the Upkeepless Construction:

13. Consider how microscopical is the rate of depreciation on the ancient buildings to which attention has been called, and remember that their brick walls have required no expense for upkeep, and will require none as long as they last.

14. The upkeep cost of some types—painting and repairs—amounts to approximately 2½% of their cost every year, according to figures published some years ago by the Committee on Fire Prevention of the Boston Chamber of Commerce. In addition to brick walls costing nothing for upkeep, even window frames, being set back from the face of the wall and protected from the weather, do not require frequent painting. $10 a year for painting frames and wood rafter ends on a small brick house is ample.

Figure 2. Whether newly built or centuries old, it is hard to tell the age of a brick house. This house was built in 1699.

15. The upkeep cost on an average $6,000 house at the very conservative figure of $100 per year ($50 below the 2½% quoted) would in ten years amount to $1,000. Upkeep on a brick house of the same cost would be only $100 for the same period. The ten year period is taken because that is the average time over which payments are spread.

Savings by Using Brick:

16. Summing up the savings so far mentioned:

Saving in upkeep cost..........	$ 900
Saving in depreciation..........	1500
Saving each ten years..........	$2400

This total does not include further savings on fire insurance premiums or on fuel.

Cost of Brick:

17. Up to recently there was but one type of burned clay construction that was fire-resistive and permanent,—solid brick. A solid brick home ranges in cost from approximately the same as frame up to $400 or $500 more for an ordinary six room house, according to the locality.

18. A home of Ideal wall construction costs the same or a little less than frame in any locality and preserves all the good qualities of solid brick, while possessing advantages not known to any other construction. A home built with the Economy wall costs even less.

JOHN D. SMALL
CONSULTING ENGINEER
CHICAGO

HEATING & VENTILATING
SANITATION
POWER PLANTS

To The Common Brick Mfrs. Assn.

Referring to the relative cost of heating a frame house versus a brick house, I have estimated the amount of radiation required to heat a given frame house to be ten per cent greater than the amount of radiation to heat a brick house of the same design and layout of rooms.

The above refers to the primary installation; but there would enter into the matter of heating other factors as time goes on which would tend to increase the cost of heating a frame house over a brick house due to shrinkage of the lumber which would affect the leakage, hence would require, in the course of a few years, possibly five per cent more heating capacity, making at least fifteen per cent more coal consumed than would be in a brick house. I consider this estimate as conservative and trust that this will be of service to you.

From what I have observed in connection with the construction of houses, if I had my choice between a frame and a brick house of the same design and dimensions, I would select the brick house, as in the long run it would represent economy in the matter of heating which would in time go a long way toward offsetting the difference in initial cost of the building; and the heating system would not cost as much as in the case of a frame house.

Yours very truly,

JOHN D. SMALL

Engineer.

A Few Selling Points of the Brick House:

19. With Ideal or Economy walls, costs the same or less than any other type.

With solid walls, it costs less than other types by the time all payments are made, counting upkeep cost until that time.

Solid, substantial, enduring appearance.

Attractive at first, grows more beautiful every year.

Walls cost nothing for paint or repair.

Little depreciation.

More fire-safe.

Saves money on fire insurance premiums.

More money can be borrowed to build it.

Takes less fuel to heat.

Coolest in summer, warmest in winter.

Has high loan value, should it be necessary to borrow money at any future time.

Retains high sales value for generations.

BRICK, THE MOST ECONOMICAL BASEMENT WALL

Three Types of Basement Wall:

1. Only three types of basement wall material are ever considered in good construction,—brick, stone and concrete. Stone, generally rubble stone, is still used but in decreasing quantity for foundation walls in districts where it is easily obtainable. Concrete has been much exploited for use in basement walls. Intensive sales methods cannot change the basic fact, however, that brick remains the simplest, the most economical, the most impervious, the most quickly erected, the best appearing and the most satisfactory material for such use.

2. It will be recalled that up to a few years ago brick was the prevailing material used for foundation walls, and that such walls gave, and still give, universal satisfaction.

Brick Cuts Down "Overhead":

3. The remarkable simplicity of brickwork commends it to every contractor who realizes the great advantage of having one set of mechanics begin and completely finish a wall at one operation, using the very simplest equipment. With brick there is also the least chance for unexpected items of expense. The integrity and appearance of brickwork is a known quantity before it is built. Brick safeguards the contractor's profits.

Little Equipment Is Needed for Brick Basement Walls:

4. A mortar box, mortar boards, a sand screen and a few trestles—that's about all that is needed for brickwork equipment. For chimneys and independent piers, trestles and scaffold plank will be required, but joists for the upper stories can often be used for the latter. The lower part of the exterior wall is generally built from the excavation, the upper part from the grade.

5. Brick construction eliminates the expense and trouble of building elaborate runways, purchasing high priced equipment and falsework, moving it around, repairing and overhauling it and storing it between jobs. Machinery and equipment depreciate and become troublesome. Build all the walls of brick and don't tie up extra money in equipment. Use it to finance another job.

Brick Basements Require Less Excavation:

6. When building a brick foundation wall the excavation need be but slightly larger than the house itself.

Build With Brick and Keep the Basement Clear:

7. Note in Fig. 3 how clean and free from obstructions the brick basement is. Brick construction provides a basement with full working space. No

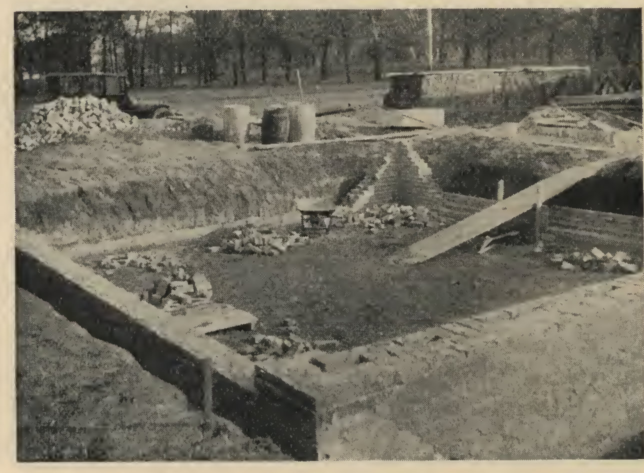


Figure 3. Note the small amount of equipment needed and the simplicity of building a brick basement.

material is carried into the basement except that which is actually placed in the walls. Consequently none has to be carried out afterwards. Brick eliminates expensive mess and expensive bother.

Brick Foundations Save Time:

8. As soon as the excavation is finished the bricklayers start and do not have to wait for any other trades.

Brick Eliminates Much Supervision:

9. One bricklayer and a laborer can build the brick basement walls of a home in a few days. By eliminating many operations, brick eliminates also the supervision of men required to perform them. The more men on a job the more it costs to "hire and fire" them or to move them from one job to another, and to keep track of their time. Brick reduces the number of men to the minimum and saves personal time and worry for the contractor.

Brick Walls Have Great Stability:

10. Owing to its enormous factor of safety and the thorough bonding of all the brick units, the brick wall will easily resist considerable unexpected thrust and stresses.

Brick Basements Moisture Resistive:

11. Well burned brick are much harder, more impervious and have less absorption than ordinary concrete or concrete blocks. The material in the mortar joints is of the same general nature as concrete, except that it is richer, but with brick the mortar joints form only a fraction of the area of the wall and the less mortar or concrete exposed, the less danger of penetration of moisture.

12. It is much safer and better construction, however, to properly damp-proof or waterproof any basement wall, of whatever material constructed; and the logical place for such water or damp-proofing is the exposed side. Placed in this position it prevents the penetration of moisture into any portion of the wall itself. The character of the water-proofing should be proportionate to the degree of dampness in the soil.

13. Condensation forms less easily on a brick surface than on a wall surface of other materials.

Brick Basements Unaffected by Alkali:

14. In localities having alkali in the soil, only brick should be even considered, some other materials having a tendency to soften and disintegrate in such places.

Brick Basements Have Greater Sales Value:

15. The brick wall presents no imperfections of surface, no unsightly bulges or patched up portions. The rich coloring of well laid brickwork gives distinction to any wall built of it, whether it be the foundation only, viewed from the outside or inside, or whether the wall extends entirely to the roof.

16. A brick basement will help to get a good price for the house, for the buying public appreciates a good looking basement. Should it be desired to afterward finish a basement room as a children's play room, billiard room, or for any other purpose, remember that the brick surface is unexcelled as a rich background for pictures, rugs, wrought iron ornament or other decoration

BRICK, EASY TO USE; GIVES INCOMPARABLE RESULTS

Convenience of Brick:

1. Quite apart from considerations as to which material gives the best service to the owner, contractors find it to their own interest to use brick in preference to any other material.

2. The contractor is interested primarily in getting the building up and off his hands as quickly as possible, consistent with the time required to make a good job. Brick is the one material which can almost always be obtained locally without delay and rail transportation expense.

3. Brick can be stored in any kind of weather without deterioration. Brick does not check, warp or split and does not spoil when wet. Wetting, in fact, saves labor, for brick should be laid while wet.

Little Waste With Brick:

4. The ordinary brick supplied to a job are generally handled in the cheapest possible way. They are dumped from wagons with but little breakage and every bat can be used as backing or filling in. Contractors know that some other material must be handled carefully to prevent loss or breakage and even then the percentage of waste is high.

No Special Sizes and Shapes of Brick:

5. Brick is an extremely flexible material, because of the small and standard size of its units. Special sizes and shapes for corners, jambs and other locations are not required. This simplifies ordering, storing and using material. There is no possibility of losing time and money by having to wait for or sort out special sizes for special locations.

Little Chance for Weak Spots:

6. Every portion of every cubic foot of brick is constructed of material having a very high factor of safety; and is laid by, and comes under the personal scrutiny of a high grade mechanic. The chance of a brick wall or pier containing weak spots is remote. It will always carry the load it is designed to bear. The strength of brickwork does not depend on any speculative operation.

Brick Resists Heat and Cold, and is Always Dry:

7. The best insulation against heat, cold and dampness is provided by the wall of brick. Everyone knows how cool the inside of a brick building is on a hot day. In winter it keeps in the heat just as efficiently as it keeps the house cool in summer.

8. The solid brick wall furred, or the Ideal wall unfurred is always dry. It is proof against dampness coming from the outside, and condensation from within.

Alterations Easy With Brick Walls:

9. If an addition is to be made, a new wall, pier, or flue can easily be joined to an old one at any point.

10. New openings can easily and quickly be made, and every brick taken out can be used over again, no matter how long the wall has been standing. The enormous strength of the brick wall makes the safe cutting of even wide openings perfectly feasible under most conditions. Cutting new openings throws more load on the parts of the wall that are left. The brick wall has great reserve strength to carry these extra loads. Because of the small size of the brick units, openings can be cut to the exact dimensions desired.

Brick Bearing Surfaces:

11. One of the most important functions of a wall is to support the floors and the roof. A brick wall of either solid, Ideal, or Economy construction forms a splendid solid bearing surface. The wall being built of small bonded units, the load is quickly transmitted over a large area.

Brick Has High Salvage Value:

12. The brick wall successfully resists the action of fire and a brick wall does not have to be rebuilt

when the burned structure is restored, unless the wall has been thrown down by mechanical forces, such as falling beams. It is those advantages that secure to the brick building favorable insurance rates.

13. Be sure, therefore, that all the bearing members in your building rest upon brick, for these are really fire-resistive. Run the brick right up to the roof.

Brick Piers Are Permanent:

14. Always use brick piers in the basement for supporting beams. Brick is not affected by dampness, never shrinks and never rots.

Brick Piers Cost Less and Are Superior to Metal Stanchions:

15. Brick piers are less expensive and more convenient than metal stanchions. With the latter, the level of the footing must be figured to the fraction of an inch or the top will not line with the soffit of the beam. Both the stanchion and the beam also require bracing and wasted labor until the floor joists are placed. The base of the stanchion, being small, must have a footing strong enough to spread the concentrated load. The brick pier is rigid and stable as soon as built and of course requires no bracing; courses can be adjusted to come to any exact height; and the pier is fire resistive.

16. Stanchions are likely to rust, and either with or without concrete filling, cannot be classed as fire-resistive. Filled with concrete and reinforced in the fill, with structural steel shapes, reinforced steel pipe are given only ¾ hr. fire rating. Filled with plain concrete, they are given only 25 min. fire rating.*

17. Records show that many fires start in the basement; therefore make every pier and partition in the basement of brick. An all-brick basement helps to sell the house.

Brick Paving:

18. In localities where brick is of a hard quality, it may be used to pave the basement floor. Such a pavement adds greatly to the appearance of any basement. Ask the brick manufacturer in your district whether his brick will give good service when used for this purpose.

Brick Facing for Kitchen Walls:

19. The kitchen wall always has a great deal of hard wear and should have a surface that cannot be disfigured. The walls of kitchens in houses of the better class are sometimes laid with brick exposed up to the height of the doors. A projecting course of brick, or a small wood mould, is run around the room at this height, the wall above being plastered.

20. This treatment is a little more expensive than a plastered wall but looks much neater. It has a surface that stains, grease or smoke will not disfigure.

21. If brick are laid flat, this treatment involves the construction of 4" brick partitions under other than outside walls, forming a small room in the basement, the same size as the kitchen above. This room can be used as a cool storage room for vegetables or for many other purposes. If brick are on edge the weight can, in some cases, be carried on the wood floor construction; the brickwork being attached to the studs by tenpenny nails driven in the studs at the level of the joints.

22. Even if the kitchen walls are plastered always allow the brick behind the range to "show."

23. If a painted surface is preferred, the brickwork can be sized and enameled or painted white or any color desired.

Roofs:

24. We strongly urge the use of only fire resistive materials for the roof of any home, for unless protected by a fire resistive covering, the roof forms a vulnerable spot against adjacent fires. Fires are often communicated from one house to another by flying sparks setting fire to shingle roofs. Fire prevention experts pronounce the wooden shingle one of the prime causes of conflagrations.

25. The most beautiful and most fire-resistive roof covering is that of burned clay tile and next in order comes slate. Concrete tile are also fire-resistive. but their coloring does not stand strong sunlight, Asbestos shingles are fire resistive and asphalt shingles do not spread fire.

Protection at Hazardous Places:

26. In view of the many fires which start in basements we suggest that in addition to building an all brick basement with no wood or iron posts or wood partitions, the wood joists at the ceiling be protected by some fire resistive material. Plaster on metal lath or gypsum board is excellent for this purpose; also under and at side of all stairways; in closets and many other hazardous places around the house.

Average Weight of Solid Brick Walls.

Brick Assumed to Weigh 4½ lb. each. ½" Joints Filled with Mortar

Area in Sq. Ft.	4-in. Wall	8-in. Wall	12-in. Wall
1	36.782 lb.	78.808 lb.	115.414 lb.
10	368	788	1 154
20	736	1 576	2 308
30	1 103	2 364	3 462
40	1 471	3 152	4 617
50	1 839	3 940	5 771
60	2 207	4 728	6 925
70	2 575	5 517	8 079
80	2 943	6 305	9 233
90	3 310	7 093	10 387
100	3 678	7 881	11 541
200	7 356	15 762	23 083
300	11 035	23 642	34 624
400	14 713	31 523	46 166
500	18 391	39 404	57 707
600	22 069	47 285	69 249
700	25 747	55 166	80 790
800	29 426	63 046	92 331
900	33 104	70 927	103 873
1000	36 782	78 808	115 414
2000	73 563	157 616	230 828
3000	110 346	236 424	346 243
4000	147 128	315 232	461 657
5000	183 910	394 040	577 071
6000	220 692	472 848	692 485
7000	257 474	551 656	807 899
8000	294 256	630 464	923 314
9000	331 037	709 272	1 038 728
10000	367 819	788 080	1 154 142

*Fire Tests of Building Columns. See page 55.

BRICK IS BEST FOR FIRE-RESISTIVE CONSTRUCTION

1. The scope of this book permits of only the briefest mention of this type of building, which may include industrial buildings, schools, hotels, apartment houses, social buildings and many other structures.

Brick, Highest Class Construction:

2. Modern industrial structures are built with due regard to the advertising value of a dignified design. Standing in well kept grounds, such buildings are a distinct asset to any business.

3. Economy of construction and safety against fire are essential qualities in all types of buildings under this class. The safety of the occupants is one of the most important factors in the construction of any building.

4. Brick assists in the carrying out of any architectural conception by the beauty of its surface.

5. Brick is the most economical fire-resistive material that can be used for foundation walls, bearing walls, interior and exterior piers, curtain walls and for fire-resistive column protection.

6. Whether the floor construction is to be of steel, concrete or mill construction, advantage may with profit be taken of the economy and superior qualities of brick walls and brick piers above and below grade.

Inspection Easy During Construction:

7. Building brickwork is a clean and neat operation, with nothing "messy" about it. The integrity of brickwork is apparent. It makes a job that is excellent in appearance and in fact. Every portion is in plain sight during erection, making inspection easy.

Brick Resists Blows and Impact:

8. In many industrial buildings and garages the interior walls have to resist impact and blows. Brick will take heavy punishment without material damage, because the blows are resisted by the inertia of a well bonded mass.

Brick Resists Direct Pull:

9. Brick makes the strongest wall to which to anchor wood guards, shafting, plumbing work, wall radiators, etc. It can also be plugged without damage and develops great resistance to direct pull, owing to the fact that brick is laid in small units, making a thoroughly bonded construction. Nailing blocks are also easily built into any type brick wall.

Window and Door Frames Easily Set In Brick:

10. Brick is the only satisfactory material for walls in which windows or door openings occur or in which such openings might be placed subsequently. Steel or wood frames are set and bricked in as the wall goes up, the brickwork being fitted accurately and easily to the frames. The numerous courses also make it easy to have the joints coincide with the sill and head lines of windows or other openings.

Brick Piers:

11. Attention is specially directed to the advantage of using brick piers, either solid or hollow, laid with brick on edge.

Brick Column Protection:

12. Column protection one brick (3¾") thick, brick laid flat, is given an official five hour fire resistance rating. (See report of tests, page 56.)

13. When erecting a steel frame building with fire resistive curtain or spandrel walls, the brick protection for engaged columns is, of course, built up with the brick walls, eliminating the expense of special operations. Brick protection for independent columns is quickly and economically erected.

Interior Finish:

14. Plaster can be applied directly to a brick surface, without any chipping or other expensive preparation of surface and with no uncertainty as to whether the plaster will stay on.

15. In many cases the beautiful natural surface of the brickwork may be taken advantage of for interior finish, either for the whole interior of the building or for special rooms. The brick surface may be laid in a simple or elaborate bond or effective special designs may be worked out. In any case the advantage of a continuous surface of attractive brickwork for walls and engaged or independent column coverings is apparent. If fireproof brick floors are used the ceiling may also be formed of exposed brickwork.

Saving by Decorating Directly on the Brick:

16. In many buildings such as schools, and in much industrial work, it is possible to reduce the cost of the building by omitting the plaster and dull painting, enamelling, or decorating the interior directly upon the brick.

Exterior Walls:

17. Brick exterior walls are found in all city building ordinances as well as in the recommendations of insurance underwriters. The pilastered form of wall gives large window areas and furnishes support to the main girders of the floors where needed, or a flat wall may be used according to requirements. The former general type of construction may be carried out either in the form of curtain walls or panel walls at the choice of the designer.

Fire and Party Walls:

18. Buildings of large area should be divided into separate sections by fire walls, thus reducing the liability to one fire and giving an opportunity to place hazardous goods in one section and less hazardous goods in remaining sections.

Enclosures and Fire Towers:

19. Stairways, elevators and other shafts or openings extending from one floor to another should be enclosed in brick walls extending above the roof.

20. Fire towers should either be placed so that one side is formed by an exterior wall and provided with an outside balcony, accessible from each story on both sides of the tower; or the tower may be constructed within the building, connecting with an outside vestibule open to the weather, the vestibule having openings at each story closed with fire doors.

Fireproof Brick Floors:

21. The use of brick arch construction is worthy of the serious attention of architects and engineers for general floor construction and for vaults.

22. The brick arch floor is about the strongest type of floor arch for the span it occupies and the type shown in (a) Fig. 4 is probably the most fire-resistive of any system that can be employed.

23. There are two types of this floor, that shown by (a) Fig. 4 having the highest fire resistance, the flanges of the beams being protected by terra cotta skewbacks. Similar construction, but with exposed tie rods, is employed for the floors of the principal stories of the Government Printing Office at Washington, D. C.

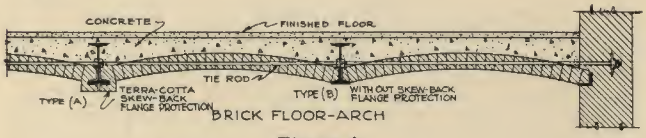


Figure 4.

24. Experiments show that brick arches will stand very severe pounding and a great deal of deflection without failure.

25. Arches need not be more than 4 in. thick for spans up to between 6 and 8 ft. (the most desirable span), if the haunches are filled with concrete level with the top of the arch. Tie rods should always be employed.

26. A 4 in. brick arch, 6 ft. span, well grouted and levelled off with concrete should safely carry 300 to 400 lbs. per sq. ft. The weight of this floor without the concrete fill is about 40 lb. per sq. ft. The ceiling so formed has all the neat and attractive appearance of brickwork and commends itself for industrial and other work.

27. A finished floor of cement, a wood floor on sleepers or a wood block or any other finished floor desired may be used.

28. To lay this floor in the most economical way the brick may be laid upon the centering touching each other at the soffit, the wedge shaped joints being filled with grout.

Tie Rods; Size and Spacing:

29. Tie rods are employed to prevent the beams being pushed apart, especially in the outer bays. They should run from beam to beam from one end of the floor to the other. If the outer arches spring from an angle as in Fig. 4, the tie rods in this bay should be anchored in the wall with large plate washers.

30. Rods should be located in the line of thrust, ordinarily below the half depth of the beams and in some cases near the bottom flanges. Arches should be designed, however, so that the rods will be protected from fire by keeping them above the soffit of the arches. This also gives a better appearance.

31. Rods are spaced generally in the proportion of eight times the depth of the supporting beams but never more than 8 ft. on centre. Their size should be proportioned to the horizontal thrust of the arches, this horizontal thrust being found as follows

$$T = \frac{3wl^2}{2R}$$

T = pressure or thrust in lbs. per lin. ft. of arch.

w = uniformly distributed load on arch in lbs. per sq. ft.

l = span of arch in feet.

R = rise of arch in inches.

The rise is measured from the spring line to the soffit in the middle.

32. Having found the thrust, the spacing of the rods of any particular size may be readily determined by dividing the safe load given for that size of rod in the table following, by the thrust. The result will be the spacing in feet.

Safe Load in Pounds on Round Rods

Stress 16,000 lb. per sq. in.

Diameter Inches	Plain Rods Load in Pounds Based on Area at Root of Thread	Upset Rods Load in Pounds Based on Full Area of Rod
½	2 016	3 140
9/16	2 592	3 960
⅝	3 232	4 910
¾	4 832	7 070
⅞	6 720	9 620
1	8 800	12 570
1⅛	11 104	15 900
1¼	14 288	19 630
1⅜	16 910	23 750
1½	20 720	28 270

33. Much of the data on the strength of fireproof brick floors and proportioning of tie rods is quoted from "Kidder's Architects and Builders' Handbook."

FIRE, PARTY, AND DIVISION WALLS SHOULD BE OF SOLID BRICKWORK

Practical Experience and Laboratory Tests:

1. (See also fire tests on column coverings, page 56.)

2. That brickwork is fire resistive to a remarkable degree is a fact attested by innumerable examples in which disastrous fires have spread and devastated property until they encountered structures built solidly with brick A brick chimney, standing alone and uninjured in the ashes of a burned home, is an ordinary sight in almost every village.

3. The writers of building codes, in creating fire zones in congested districts to make lives and property safer, find their chief ally against the spread of fire in good honest brick construction. Brick has proved itself fire resistive so often in actual experience that until recently no laboratory fire tests were ever made upon it. These tests amply show that the universal confidence felt in the fire resistiveness of brick has not been misplaced.

New Materials Should Pass Tests:

4. In view of the fact that priceless human lives and valuable property may depend upon the proper functioning of a wall built as a fire barrier, it is evident that code makers, architects and engineers should regard no new material as fire-resistive until those promoting it can produce actual test data from a reliable, disinterested authority of the highest

standing, such as the U. S. Bureau of Standards or the Underwriters' Laboratories, to substantiate their claims. The favorable opinion of a manufacturer or of any other person will not aid a fire wall in stopping the spread of fire and the issues at stake justify those who may be held responsible in being extremely conservative in this matter.

5. In the October, 1920, National Fire Protection Association Quarterly, C. E. Worthington says: "Walls of theoretically or generally proven insufficient character occasionally make phenomenal stops, and because these stops are unexpected they are widely advertised."

Definition of Party, Fire, and Division Walls:

6. **A party wall** is a separating wall between two buildings with different owners and occupants.

A fire wall is a vertical barrier dividing two or more parts of the same property from each other.

Division walls are walls separating buildings from each other, each being placed entirely on the property occupied by the building itself.

7. Walls in each of the above classifications should "have such stability as to remain intact after complete combustion of the contents of the building on either side of the wall; and its structural integrity shall be such as not to be dangerously impaired by the wreckage resulting from the fire or its extinguishment." (From discussion at the 1920 meeting of the National Fire Protection Association.) It was also agreed at the same meeting that a fire wall "shall have such thickness as to prevent the communication of fire by heat conduction."

National Board of Fire Underwriters Code:

8. The following is quoted from a note under "fire walls":

"The great value of solid walls in restricting the spread of fire is so well known, argument should be unnecessary to insure their use wherever suitable. A fireproof factory or warehouse with properly restricted areas between fire walls, equipped with automatic sprinklers, and having proper protection to vertical openings and windows, would be practically impossible to burn. The truth of this statement has been demonstrated many times. The folly of building otherwise is a self-evident verity.

Height of Solid and Ideal Brickwork by Courses.

Based on Standard Brick 2¼" x 3¾" x 8"

Height from Bottom of Mortar Joint to Bottom of Mortar Joint

No. of Courses	⅜" Joints		½" Joints		⅝" Joints		¾" Joints	No. of Courses
	Brick Flat	Brick on Edge	Brick Flat	Brick on Edge	Brick Flat	Brick on Edge	Brick Flat	
1	2⅝"	4⅛"	2¾"	4¼"	2⅞"	4⅜"	3"	1
2	5¼"	8¼"	5½"	8½"	5¾"	8¾"	6"	2
3	7⅞"	1'— 0⅜"	8¼"	1'— 0¾"	8⅝"	1'— 1⅛"	9"	3
4	10½"	1'— 4½"	11"	1'— 5"	11½"	1'— 5½"	1'—0"	4
5	1'— 1⅛"	1'— 8⅝"	1'— 1¾"	1'— 9¼"	1'— 2⅜"	1'— 9⅞"	1'—3"	5
6	1'— 3¾"	2'— 0¾"	1'— 4½"	2'— 1½"	1'— 5¼"	2'— 2¼"	1'—6"	6
7	1'— 6⅜"	2'— 4⅞"	1'— 7¼"	2'— 5¾"	1'— 8⅛"	2'— 6⅝"	1'—9"	7
8	1'— 9"	2'— 9"	1'—10"	2'—10"	1'—11"	2'—11"	2'—0"	8
9	1'—11⅝"	3'— 1⅛"	2'— 0¾"	3'— 2¼"	2'— 1⅞"	3'— 3⅜"	2'—3"	9
10	2'— 2¼"	3'— 5¼"	2'— 3½"	3'— 6½"	2'— 4¾"	3'— 7¾"	2'—6"	10
11	2'— 4⅞"	3'— 9⅜"	2'— 6¼"	3'—10¾"	2'— 7⅝"	4'— 0⅛"	2'—9"	11
12	2'— 7½"	4'— 1½"	2'— 9"	4'— 3"	2'—10½"	4'— 4½"	3'—0"	12
13	2'—10⅛"	4'— 5⅝"	2'—11¾"	4'— 7¼"	3'— 1⅜"	4'— 8⅞"	3'—3"	13
14	3'— 0¾"	4'— 9¾"	3'— 2½"	4'—11½"	3'— 4¼"	5'— 1¼"	3'—6"	14
15	3'— 3⅜"	5'— 1⅞"	3'— 5¼"	5'— 3¾"	3'— 7⅛"	5'— 5⅝"	3'—9"	15
16	3'— 6"	5'— 6"	3'— 8"	5'— 8"	3'—10"	5'—10"	4'—0"	16
17	3'— 8⅝"	5'—10⅛"	3'—10¾"	6'— 0¼"	4'— 0⅞"	6'— 2⅜"	4'—3"	17
18	3'—11¼"	6'— 2¼"	4'— 1½"	6'— 4½"	4'— 3¾"	6'— 6¾"	4'—6"	18
19	4'— 1⅞"	6'— 6⅜"	4'— 4¼"	6'— 8¾"	4'— 6⅝"	6'—11⅛"	4'—9"	19
20	4'— 4½"	6'—10½"	4'— 7"	7'— 1"	4'— 9½"	7'— 3½"	5 —0"	20
21	4'— 7⅛"	7'— 2⅝"	4'— 9¾"	7'— 5¼"	5'— 0⅜"	7'— 7⅞"	5 —3"	21
22	4'— 9¾"	7'— 6¾"	5'— 0½"	7'— 9½"	5'— 3¼"	8'— 0 ¼"	5 —6"	22
23	5'— 0⅜"	7'—10⅞"	5'— 3¼"	8'— 1¾"	5'— 6⅛"	8'— 4⅝"	5'—9"	23
24	5'— 3"	8'— 3"	5'— 6"	8'— 6"	5'— 9"	8'— 9"	6 —0"	24
25	5'— 5⅝"	8'— 7⅛"	5'— 8¾"	8'—10¼"	5'—11⅞"	9'— 1⅜"	6'—3"	25
26	5'— 8¼"	8'—11¼"	5'—11½"	9'— 2½"	6'— 2¾"	9'— 5¾"	6'—6"	26
27	5'—10⅞"	9'— 3⅜"	6'— 2¼"	9'— 6¾"	6'— 5⅝"	9'—10⅛"	6'—9"	27
28	6'— 1½"	9'— 7½"	6'— 5"	9'—11"	6'— 8½"	10'— 2½"	7'—0"	28
29	6'— 4⅛"	9'—11⅝"	6'— 7¾"	10'— 3¼"	6'—11⅜"	10'— 6⅞"	7'—3"	29
30	6'— 6¾"	10'— 3¾"	6'—10½"	10'— 7½"	7'— 2¼"	10'—11¼"	7'—6"	30
31	6'— 9⅜"	10'— 7⅞"	7'— 1¼"	10'—11¾"	7'— 5⅛"	11'— 3⅜"	7'—9"	31
32	7'— 0"	11'— 0"	7'— 4"	11'— 4"	7'— 8"	11'— 8"	8'—0"	32
33	7'— 2⅝"	11'— 4⅛"	7'— 6¾"	11'— 8¼"	7'—10⅞"	12'— 0⅜"	8'—3"	33
34	7'— 5¼"	11'— 8¼"	7'— 9½"	12'— 0½"	8'— 1¾"	12'— 4¾"	8'—6"	34
35	7'— 7⅞"	12'— 0⅜"	8'— 0¼"	12'— 4¾"	8'— 4⅝"	12'— 9⅛"	8'—9"	35
36	7'—10½"	12'— 4½"	8'— 3"	12'— 9"	8'— 7½"	13'— 1½"	9'—0"	36
37	8'— 1⅛"	12'— 8⅝"	8'— 5¾"	13'— 1¼"	8'—10⅜"	13'— 5⅞"	9'—3"	37
38	8'— 3¾"	13'— 0¾"	8'— 8½"	13'— 5½"	9'— 1¼"	13'—10¼"	9'—6"	38
39	8'— 6⅜"	13'— 4⅞"	8'—11¼"	13'— 9¾"	9'— 4⅛"	14'— 2⅜"	9'—9"	39
40	8'— 9"	13'— 9"	9'— 2"	14'— 2"	9'— 7"	14'— 7"	10'—0"	40
41	8'—11⅝"	14'— 1⅛"	9'— 4¾"	14'— 6¼"	9'— 9⅞"	14'—11⅜"	10'—3"	41
42	9'— 2¼"	14'— 5¼"	9'— 7½"	14'—10½"	10'— 0¾"	15'— 3¾"	10'—6"	42
43	9'— 4⅞"	14'— 9⅜"	9'—10¼"	15'— 2¾"	10'— 3⅝"	15'— 8⅛"	10'—9"	43
44	9'— 7½"	15'— 1½"	10'— 1"	15'— 7"	10'— 6½"	16'— 0½"	11'—0"	44
45	9'—10⅛"	15'— 5⅝"	10'— 3¾"	15'—11¼"	10'— 9⅜"	16'— 4⅞"	11'—3"	45
46	10'— 0¾"	15'— 9¾"	10'— 6½"	16'— 3½"	11'— 0¼"	16'— 9¼"	11'—6"	46
47	10'— 3⅜"	16'— 1⅞"	10'— 9¼"	16'— 7¾"	11'— 3⅛"	17'— 1⅜"	11'—9"	47
48	10'— 6"	16'— 6"	11'— 0"	17'— 0"	11'— 6"	17'— 6"	12'—0"	48
49	10'— 8⅝"	16'—10⅛"	11'— 2¾"	17'— 4¼"	11'— 8⅞"	17'—10⅜"	12'—3"	49
50	10'—11¼"	17'— 2¼"	11'— 5½"	17'— 8½"	11'—11¾"	18'— 2¾"	12'—6"	50
60	13'— 1½"	20'— 7½"	13'—10"	21'— 3"	14'— 4½"	21'—10½"	15'—0"	60
70	15'— 3¾"	24'— 0¾"	16'— 0½"	24'— 9½"	16'— 9¼"	25'— 6¼"	17'—6"	70
80	17'— 6"	27'— 6"	18'— 4"	28'— 4"	19'— 2"	29'— 2"	20'—0"	80
90	19'— 8¼"	30'—11¼"	20'— 7½"	31'—10½"	21'— 6¾"	32'— 9¾"	22'—6"	90
100	21'—10½"	34'— 4½"	22'—11"	35'— 5"	23'—11½"	36'— 5½"	25'—0"	100

"Fire walls are as useful in protecting school buildings, hospitals, hotels, state and county buildings, large residence buildings, and in fact any building having considerable area, as they are in other types of buildings. In such public buildings where numerous people are housed, many of whom may be invalids or infirm, the life saving features of properly constructed fire exits through fire walls cannot be overestimated. The additional expense of such cutoffs is slight, and neither the architectural effects, nor the utility of the building, need be affected by their introduction. Necessary openings in such walls when not large, can be efficiently protected by fire doors as artistic in finish as ordinary doors."

Underwriters Favor Solid Brick:

9. That solid brick walls amply fulfill all the exacting requirements for walls of this class is indicated by the ratings of premiums on insurance policies. Throughout the country underwriters base these premiums at par on buildings with the solid wall and increase the premiums on any wall of hollow units.

10. This increase in premium, termed a "penalty" is a recurring tax not only on the valuation of the building but upon all its equipment and entire contents.

11. These rates are based upon the safety of the building; and the solid brick wall, which better protects the "risk" and enables it to remain after the fire as a "salvage" receives the most favorable or "base" rate.

12. Another consideration influencing "penalties" is the known certainty that with walls other than solid, water damage to adjoining properties, from seepage through the separating walls, cannot be guarded against.

Authorities Recommend Solid Brick:

13. For walls of this class, the solid brick wall is found in every building code of our cities, in the code recommended by the National Board of Fire Underwriters, and is recommended by all authorities on building construction and fire prevention.

14. Rudolph P. Miller, Superintendent of Buildings of the Borough of Manhattan, says:* "In the Baltimore and San Francisco fires it was demonstrated that for outside walls brick is superior as a fire proof material to any other material used in wall construction."

*Kidder's "Architects and Builders' Handbook" page 814.

15. There are no disadvantages in solidity and safety.

Test Enclosures Built of Brick:

16. When subjecting other materials to fire tests the enclosure in which the tests are made is almost invariably built of brick, a fact which speaks for itself.

Brick Absorbs Sound:

17. Because of its unequalled capacity for absorbing sound, the solid brick wall is without a rival in this regard for party walls.

Brick Walls Preserve Owners' Rights:

18. Due to change of owners or occupants, increase of business, or enlargement of the building, it may be necessary to cut new openings in fire walls, enlarge existing openings or alter them in other ways. This can easily be done with a brick wall.

19. In the case of a party wall the foregoing advantage becomes a most important item. Each adjoining owner is entitled to the right of using the wall for his own requirements of construction. Without a wall which can be cut out at any desired height and at every required interval for the introduction of beams, joists, etc. or into which new chimneys and flues can be bonded or other changes made, one owner will be deprived of this right and be at considerable expense and lose valuable space as a result of having to build another wall; the other will lose his rebate of one-half the cost of the party wall as originally built.

20. So firmly is recognition of these facts entrenched as a right that in some states and many cities no other material than brick is permitted for party walls. In Philadelphia, for example, no material other than brick is used in the party walls of the four hundred thousand individual homes where such walls are used in that city. By an act of the State legislature, brick is specifically named as the one and only material which legally meets the requirements of a party wall.

BRICK UNEXCELLED FOR SEWERS, SEPTIC TANKS AND MANHOLES

1. Sixty years ago the trunk sewers in the older section of Chicago were installed, all built of brick. For sixty years they have resisted the powerful acids found in sewage. Floods and torrents have done their worst and even now the old brick sewers are in good condition and in constant use.

2. This is but one instance of thousands where brick has proved the ideal material for all places where the action of acids inside and outside the structure must be resisted.

3. Brick sewers are very economical to install, even large circular trunk sewers can be built with inexpensive centering or forms.

4. For more detailed information on the proper material for sewers, write to the Common Brick Manufacturers' Association, 2121 Guarantee Title Bldg., Cleveland, Ohio, for free pamphlet "Did you ever see the inside of a sewer?"

HOLLOW WALLS OF BRICK

Ideal Wall—Definition:

1. The Ideal wall is the general name used to describe all types of hollow walls built with standard solid brick—the universal and reliable burned clay product—by placing some or all of the brick on edge. There are three types of Ideal walls, all detailed in this publication, as follows:—

Ideal rolok-bak walls.
Ideal all-rolok walls.
Ideal all-rolok walls in Flemish bond.

2. Only in the all-rolok types does the exterior appearance of the Ideal wall differ from the standard and traditional brickwork with which all are familiar. In the other type—the rolok-bak wall—the face of the wall may be worked out in any bond and joint to suit the builder's taste, and the complete wall has the same appearance as a wall of solid brickwork.

Uses of the Ideal Wall:

3. Ideal walls are recommended for all purposes where walls of hollow units of other materials than brick are permitted under building code regulations or by local custom. These purposes include basement wall construction, load-bearing exterior and interior walls, isolated piers, and curtain and interior partition walls.

Substitutes for Brick Not Always Cheaper:

4. Inventive genius, always busy, has for many years sought various substitutes or alternates for brick which would "save money" for the builder. Throughout all ages and to the present moment, however, brick and natural stone have remained the basic building materials. To leave something out of the solid units making up the wall is the only way that has been found, thus far, to reduce the cost of masonry. This results in reducing also the strength of the wall, and more particularly greatly reduces its fire resistiveness. Whether or not these hollow substitutes for brick really save money is questionable. Only in certain localities is masonry built of these substitutes lower in cost than the solid brick masonry wall. It is a matter of the relative cost of brick and the substitutes, based upon their comparative cost of manufacture, their accessibility to the market where used and whether or not the building code recognizes the necessity of properly regulating the manufacture and use of the substitutes in the interest of safety. Any general statement to the effect that walls of hollow units cost less than solid brick walls is pure propaganda and not a fact applicable to all parts of the country.

Hollow Unit Walls Should Not Be Compared with Solid Walls:

5. It would be just as pertinent to say that caps cost less than hats. Some caps cost less than some hats, but it is equally true that some hats cost less than some caps.

6. A Mexican dollar has the same general size, and shape, and weight as an American dollar, but there is a vast difference in value. So it is with different types of materials of construction.

7. All building units in general use today have some merit. Nearly all are suitable for use and are serviceable *in their proper place.* No modern building unit that has yet been produced, however, has the strength,

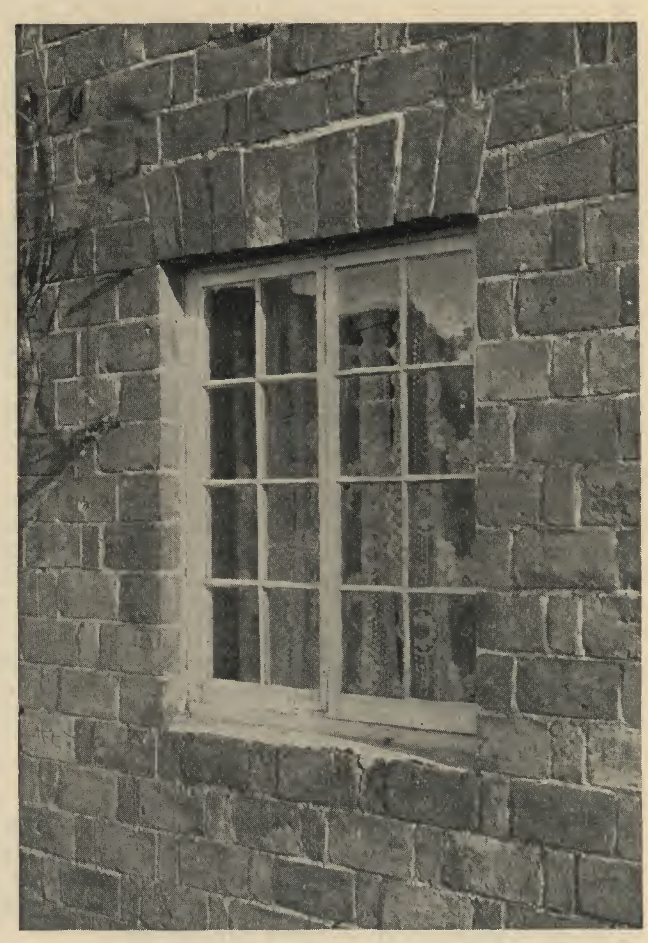


Figure 1. Detail of a charming cottage near Bridgewater, England; date of construction about 1803. All-rolok wall in Flemish bond.

fire resistiveness, and other advantages and merits of brick, and in fact responsible concerns do not promote such units as "just as good" as brick.

Ideal Wall—Highest Grade Hollow Wall:

8. Tests made in authoritative laboratories show that the solid wall of standard brick—the incomparable burned clay product—develops greater strength in compression, greater resistance to fire, lower transmission of sound and of heat and cold than any other type of masonry wall. The brick wall, both solid and hollow, retains the greatest proportion of its original strength after exposure to severe fire at high temperatures and in fact loses practically none of its strength and stability, giving a salvage value far above that of other types of building construction. Brick walls can be safely used again after long exposure to fire.

9. The foregoing statement should not be construed as a recommendation that walls specifically constructed as fire walls should be of Ideal construction. The object of a fire wall is primarily that of preventing the

"WITHE"—Definition. For want of a better descriptive term, the word "withe," used in connection with the Ideal wall, denotes each continuous vertical solid bearing section or thickness of brickwork, either 2¼" or 3¾" thick, in such walls.

Yeager and Krause, Architects

Figure 2. Rolok-bak wall house at Shaker Heights, Ohio. Basement 12″ all-rolok wall below grade; first and second floor and gable walls, 8″ rolok-bak walls bonded with Flemish headers every seventh course. (Built in 1924 by builder whose letter appears on page 20).

spread of fire, and while the Ideal wall gives the highest degree of fire protection when compared with other hollow walls, it is not so efficient as the solid wall of brick.

10. "The great value of solid walls in restricting the spread of fire is so well known, argument should be unnecessary to insure their use wherever suitable," says the National Board of Fire Underwriters' Code.

Ideal Walls Grow in Popularity:

11. For certain kinds of structures and under some conditions the solid brick wall possesses an excess of strength and of fire resistance. This fact led to the development of hollow walls of standard solid brick, (known as Ideal walls), which reduce construction costs and at the same time give the remarkable advantages that always go with the use of this ancient and dependable standard building unit.

12. In 1921 promotion of the Ideal wall was begun by the Common Brick Manufacturers' Association of America. Probably no new type of construction has ever grown to popularity in such a short time. Ideal walls, in most of the types detailed in this pamphlet, are in general use throughout the world.

13. Although thought to be new when introduced by this Association, it was found later that examples of this construction existed in nearly every part of the world where brick is used. Walls built in this fashion more than 200 years ago have been located and examined.

14. In the brief period since the promotion of hollow walls of brick began in America, the Ideal wall has been adopted by builders as the most economical type of masonry construction for walls 8″ thick and over. New building codes in many important cities have recognized and provided for Ideal walls and old codes have been changed so that the public can take advantage of this economical type of masonry construction.

15. In many smaller cities where a brick house had not been built for many years, the Ideal wall is the prevailing construction for homes today.

16. The National Building Code Committee appointed by Secretary Herbert Hoover includes Ideal wall in its recommended practice report. The National Conference of Building Officials of the United States has passed a resolution approving the Ideal wall (Page 34).

Ideal Walls Always Economical:

17. The only advantage that applies always to any type of hollow wall as compared to a solid brick wall is that the hollow wall is lighter than the solid. The question of the economy of *hollow unit* walls is a local one, inasmuch as they actually cost more than solid brick construction in many localities. But with the Ideal wall the economy advantage applies everywhere because it is built of the same material as the solid wall but requiring a smaller quantity. The saving varies according to the type of Ideal wall decided upon.

The Greater the Solid Thickness, the Greater The Insulation:

18. A talking point or sales argument used for some types of hollow building units is to the effect that they produce a warmer wall than a solid wall. The propaganda which has aimed to establish this fallacy has been so persistent that many have been led to accept it as a credible fact. Even some architects have been unduly influenced by this propaganda, and often some writer on building construction subjects falls into the error of repeating this false statement, believing it to be true.

19. The fact is, true dead air spaces, which alone have high insulating value, must be microscopical in size, and every brick contains a mass of such cells. Large air spaces in a wall are not dead air cells.

20. Tests have been made at various times to show the insulating value of wall materials. These tests have been made under such widely varying conditions, however, that when the figures are compared they are contradictory and inconclusive.

21. Some interesting comparative figures are obtained when testing walls for fire resistance. In all such tests the furnace temperature is controlled to conform as nearly as possible to a "standard time temperature curve" and the rate of increase in the temperature of the unexposed side of each type of wall is therefore the measure of its insulating value. Bureau of Standards figures show that thin shell hollow unit walls 8 inches thick reached the critical temperature of 482° F. on the unexposed side of the wall in 3 hrs. 5 min.; that thick shell hollow unit walls 8 inches thick reached the same temperature in 4 hrs. 10 min.; *and that in ten tests of solid brick walls 8 inches thick not one of the walls attained that temperature on the unexposed side even at the end of the tests, which lasted six hours, the average temperature at the end of the tests being only 287° F.* Even brick walls only 4″ thick did not reach the same critical temperature on the unexposed side until 2 hrs. 28 min. (average of two tests) after the start of the tests. Ideal wall figures are given on page 33. The figures are summarized in the following table.

Fire Test Figures Indicating Insulating Value of Various Types of Wall Construction

Type of Wall	Time at which 482° F was reached on unexposed side of wall.
8″ hollow unit, thin shells..........	3 hrs. 5 min.
8″ hollow unit, thick shells..........	4 hrs. 10 min.
8″ Ideal walls (average of 3 tests lasting 6 hrs.)......................	5 hrs. 40 min.
8″ solid brick walls................	Not attained at end of 6-hr. tests. Temperature at end of tests averaged 287° F.
Brick walls only 4″ thick...........	2 hrs. 28 min.

22. These figures clearly prove that the solid brick wall is the very best insulation against heat and therefore against cold and that the Ideal wall comes next in point of efficiency.

Exterior Masonry Walls Should Generally be Furred or Waterproofed:

23. As a general safe rule, all types of exterior masonry walls, of whatever material constructed, and whether solid or hollow, should be furred, lathed, and plastered on the inside surface to ensure non-passage of moisture and to guard against condensation. Satisfactory results are also often obtained by waterproofing the inside surface.

24. This Association makes this super-cautious general recommendation to include all-rolok construction in Flemish bond also, even though a multitude of structures have been built in that construction and plastered directly on the brickwork, and in all that number not more than half a dozen cases have been reported where traces of moisture appeared on the inside face of the wall, and that result was found to be due in every instance to carelessness in construction.

25. It is almost impossible under practical conditions for a well burned header to carry moisture along its entire length by capillary attraction. Moisture can, however, be conducted under severe conditions through a continuous mortar joint either of cement or lime mortar.

26. In most types of the Ideal wall there is no continuous mortar joint from front to back of the wall. (Where plaster is to be applied direct such continuous through mortar joints must be avoided in case small sections of the wall are built solid for various purposes).

27. In most types of the Ideal wall there is also an additional safeguard in the fact that a slight steady circulation of air within the cavities dries out any small amount of moisture that might reach the portion of the header in the hollow space.

28. The properly constructed Ideal all-rolok wall in Flemish bond has established an enviable reputation for itself in many sections of the country as a wall which can be confidently relied upon to be thoroughly dry when plastered directly on the brick.

29. If in any locality it has been found by experience that walls of hollow units do not need to be furred and lathed, then the various types of Ideal walls used under the same conditions and with the same grade of workmanship, can be depended upon with much greater confidence to be dry and furring can be omitted.

Waterproofed Walls in California Climate Need No Furring:

30. Highly successful results have been accomplished in California and other parts of the country by waterproofing the inside face of solid walls, or by dipping about half of the length of each header in Ideal walls in a waterproofing mixture of equal parts of asphaltum and distillate, the waterproofed end of the header being placed toward the inside of the wall. In that climate walls so treated do not need to be furred, and the plastering may be placed directly on the surface of the brickwork. This treatment is quite inexpensive.

Ideal Wall is Light Weight Wall:

31. Where lightness of weight in masonry is considered an advantage, the Ideal wall, when built as an independent wall or when used as a backup for exposed

Figure 3. House at Dobbs Ferry, New York. All-rolok wall in Flemish bond. *Theodore Meyer, Architect*

brick, stone, or terra cotta is lighter than the average hollow unit construction. The Ideal wall is especially desirable and economical for curtain or panel walls and for inside partitions in steel or reinforced concrete skeleton buildings on this account. When the Ideal wall is used as back-up construction, the facing material becomes a part of the masonry, making a wall that is thoroughly bonded together.

Ideal Wall Resists Blows and Impact:

32. One of the great advantages of brick in hollow walls is the strength of its sturdy "withes"* and their high resistance to impact or transverse stress. The thickness of a standard brick, $2\frac{1}{4}''$, is the narrowest bearing surface in any part of the wall. In garages, warehouses or other industrial structures where by accident there may be occasional impact against the wall, the Ideal wall will be found more suitable than any other type of hollow wall because such impact is resisted by the inertia of the considerable mass of solid material in the withes of the wall, which do not break or shatter. (See also par. 11 item *d*, page 34.)

Light Burned Brick for Interiors and Backing:

33. Salmon or light burned brick are serviceable in the back withes of Ideal wall, when they are not exposed to the weather. This permits the use of the lowest priced brick obtainable and thereby reduces cost. Walls of salmon brick have more than enough strength for ordinary purposes.

Ideal Walls Have Great Sound Resistance:

34. Soundproofness (not an important factor in ordinary wall construction) according to scientific tests increases in direct ratio with the increase of the solid mass of the material in the wall. Consequently the hollow wall of solid brick has great sound resistiveness.

Solid Sections Constructed Without Change of Material:

35. Wherever pilasters or buttresses or short sections of the wall are designed to carry heavy concentrated loads, these can without change of material be constructed of solid brickwork. Small sections of solid wall can also be built for a variety of purposes, as for instance chimneys, fireplaces, bearings for heavy girders, skewbacks for arches, the secure anchoring of metal straps, guards, shafting, etc. With the Ideal wall there is no waste or loss of time in building such solid sections, as the mason is working always with one standard masonry unit only—brick. No special material has to be taken on the scaffold.

36. No problem is involved in building around window and door openings or at corners or in the working out of any detail in construction with Ideal walls. Brick units are comparatively small and this makes brick construction "flexible." The normal quantity of "bats" or broken brick are used in the Ideal wall so that no material is wasted. Even small pieces of brick can be built into the wall.

**Withe. Each continuous solid bearing section or thickness of brickwork, either $2\frac{1}{4}$ in. or $3\frac{3}{4}$ in. thick, in Ideal walls.*

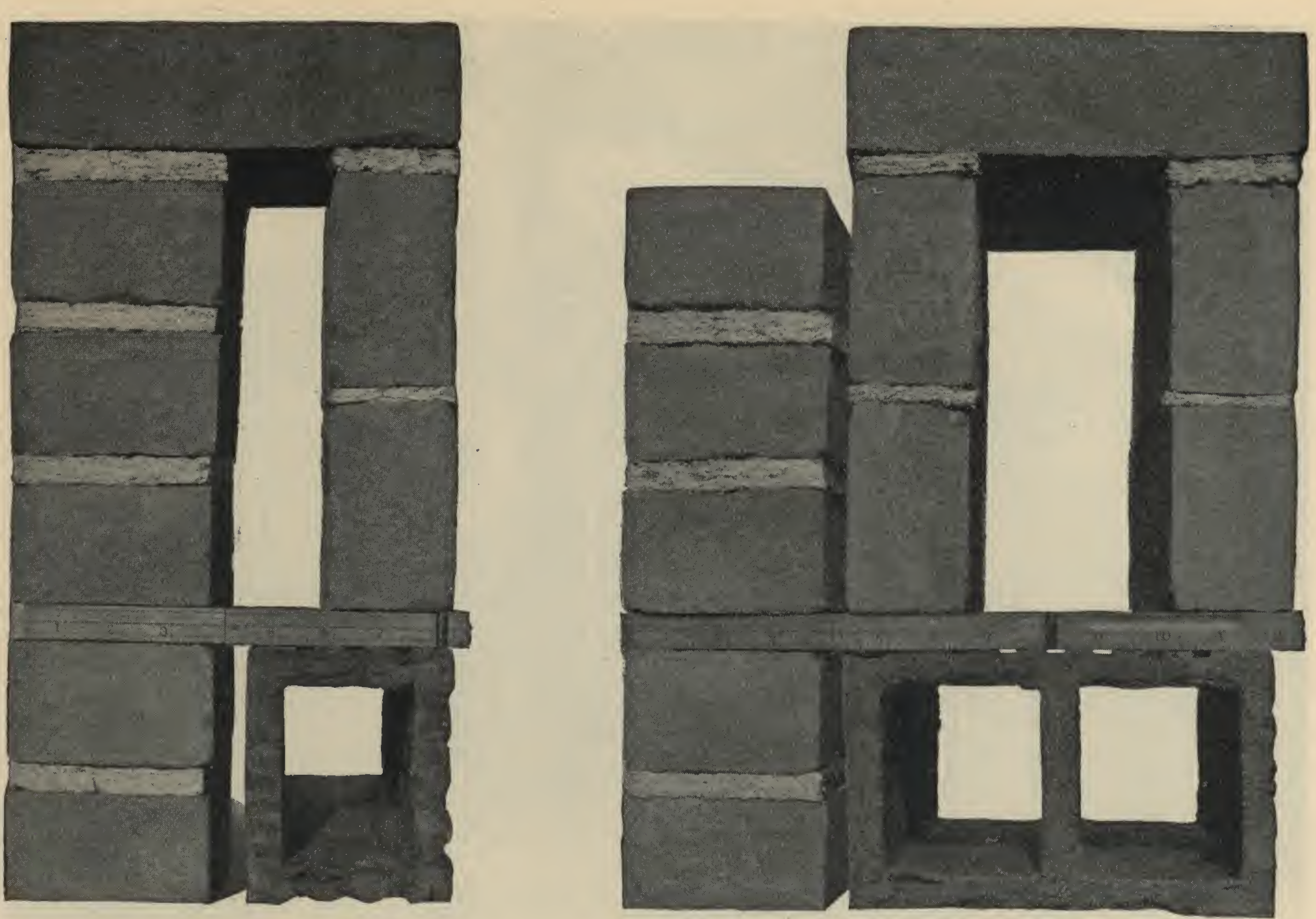


Figure 4. The illustrations show, below the rules, cross section views of 8″ and 12″ walls constructed with brick facing and typical hollow back-up units; above the rules, 8″ and 12″ rolok-bak walls. Total net thickness of solid bearing material in the two $\frac{5}{8}$″ shells of the hollow unit on the left—$1\frac{1}{4}$″; in the three shells in the right hand illustration—$1\frac{7}{8}$″. Total net thickness of brick on edge withe forming the backing of the rolok-bak wall, left hand illustration (one withe) $2\frac{1}{4}$″; right hand illustration (two withes) $4\frac{1}{2}$″. These illustrations are shown for the information of building code officials in cities where hollow unit walls are now permitted, as proof of the sturdiness, stability, and great strength of the Ideal wall and as compelling reasons why the Ideal wall should be permitted under the same codes.

No Special Brick Required—Standard Brick Throughout:

37. It should be emphasized that the brick used in all types of Ideal wall construction is ordinary brick; the reliable burned clay product that may be obtained at any brickyard, and that no special shapes or sizes are required. In other words, the Ideal wall is not a wall of hollow brick, but is a hollow wall of solid brick.

Factors Affecting the Strength of the Ideal Wall:

38. It is of great importance that each withe of the Ideal wall has a sturdy solid thickness of at least $2\frac{1}{4}$″, and this is of special advantage on the side of the wall which supports joists, because a joist which deflects even slightly under load obviously transmits the weight to the edge of the masonry upon which it rests.

39. In laying the Ideal wall, the brick in every withe will always be in vertical alignment and the wall is always thoroughly capable of taking its full load.

40. The Ideal wall is bonded or tied together in the direction of its thickness with the same sturdy solid brick units that form its withes.

Investigate Lower Cost and Other Claims of Substitutes:

41. If anybody attempts to compare hollow walls with solid walls, either as to cost or as to number of units per square foot, check up carefully the merits of the Ideal wall with the authentic record and performance of all other types of hollow unit walls. Use your pencil and estimate your local costs from the data in the following pages and find that by the use of brick—the good old unit you always have used—you can produce hollow walls that are better in every particular, and at lower cost.

ADVANTAGES OF IDEAL WALL SUMMARIZED

Lowest cost masonry wall possible to build for construction 8″ thick and over.

Strongest hollow masonry wall.

Most highly fire resistive hollow wall—not damaged by long exposure to high temperatures or water used in extinguishing fires.

The dryest hollow masonry wall.

Contains thickest withes and has large percentage of solids to voids.

Lighter in weight than the average hollow unit wall of brick substitutes .

Built of standard brick—no special sizes or shapes.

Bonds perfectly with any facing material.

Recognized by National Building Code Committee and National Building Officials' Conference

The Ideal wall means satisfied bricklayers.

HOLLOW WALL DESCRIPTION AND CONSTRUCTION DATA

THE ROLOK-BAK WALL

General Description:

1. The rolok-bak wall is a general utility wall, and may be employed not only for exposed walls but for unexposed walls and for basement construction. It forms a perfect base for stucco where that finish is particularly desired, and for plaster in interior walls.

2. The exterior four-inch thickness is laid with brick placed flat and the backing is laid of brick on edge. On the exterior, therefore, the brickwork has the usual appearance of brickwork laid in the traditional way and may be faced in any bond. The wall may be 8″ thick or in multiples of additional 4″ thicknesses.

Figure 5. Rolok-bak wall apartment buildings at Cleveland, Ohio. Basement wall below grade is 12″ all-rolok wall in Flemish bond. Basement above grade, and first floor walls are 12″ rolok-bak walls. Second and third floor walls are 8″ rolok-bak walls. (Constructed in 1923 by builder whose letter appears on page 20).

3. In the 12″ thickness, there are two types of the rolok-bak wall—the *standard* (page 22) and the *heavy duty* (page 23).

4. In the standard rolok-bak wall, the flat header course is arranged in basket weave bond so that it ties the whole wall together as shown clearly in the illustrations. This allows of the greatest saving in cost both in labor and material. A flat header course is laid with less labor than a solid header course on edge and the wall requires fewer brick and less mortar per square foot.

5. The standard rolok-bak wall is designed for bearing walls of buildings in the multiple residential and other classes where a 12″ thickness of wall is required and floor loads are moderate, such as apartment buildings, hospitals, clubs, office occupancies, etc.

6. The heavy duty rolok-bak wall is designed for situations where heavy floor loads are to be carried.

7. The heavy duty wall is constructed by building the withes of the backing of three courses of stretchers on edge, the fourth course being a continuous course of headers on edge. On this course is laid a continuous course of flat headers, to tie the facing to the backing, with a flat stretcher fill behind it.

Appearance:

8. The Ideal rolok-bak wall has exactly the same exterior appearance as ordinary brickwork.

9. While the illustrations show this type of construction in common bond, any of the other bonds may be used instead. Even with the solid brick wall, all headers not necessary for strength are bats not extending through into the backing, when the more

Figure 6 Foundation wall below grade of apartment buildings shown in Fig. 5. 12″ all-rolok wall in Flemish bond.

The Best Homes Company

Quality Homes at Right Prices

1300 Schofield Building

ANDREW PENTLAND
Pres. and Gen. Mgr

ADOLPH PECK
Vice President

Phone Main 4487

Cleveland, Ohio

The Common Brick Manufacturers' Association
2121 Guarantee Title Building
Cleveland, Ohio

Gentlemen:

I will confess that it took me some little time to convince myself that the rolok-bak wall is not only better but cheaper to build than any other type of 8 or 12-inch masonry.

For the past two years I have used exclusively rolok-bak wall in all my work in residences and apartments. For many years prior I had used hollow units wherever the code permitted it, and I made the change to rolok-bak wall principally because I saved money by doing so, and, secondly, because I find the bricklayers would rather handle brick than any other kind of masonry unit.

You will be interested to know that over a period of two years my bricklayers have averaged 1200 to 1300 brick per day on edge in backing up a 12-inch Ideal wall, and approximately 700 to 800 brick per day in the backing up of the 8-inch Ideal wall.

I have also found economy in using only one kind of back-up material, and this is especially true in the saving of time in laying the wall around window and door openings.

Should I be able to furnish you with any further information pertaining to these types of wall, I will gladly do so.

Yours very truly,

Andrew Pentland

President and General Manager

elaborate bonds such as Flemish, English, English cross, etc., are used; because the bricklayer can save much time by building the outside 4″ thickness "header high," afterward backing up. The same method of forming these more elaborate bonds by using bats is followed when building the rolok-bak wall.

The Flat Header Course:

10. Every seventh course of brick laid flat is a header course, to bond the facing to the backing.

11. Most building codes require this course to consist entirely of headers, a "continuous header course." Other codes permit this course to consist of headers and stretchers placed alternately—a "Flemish header course."

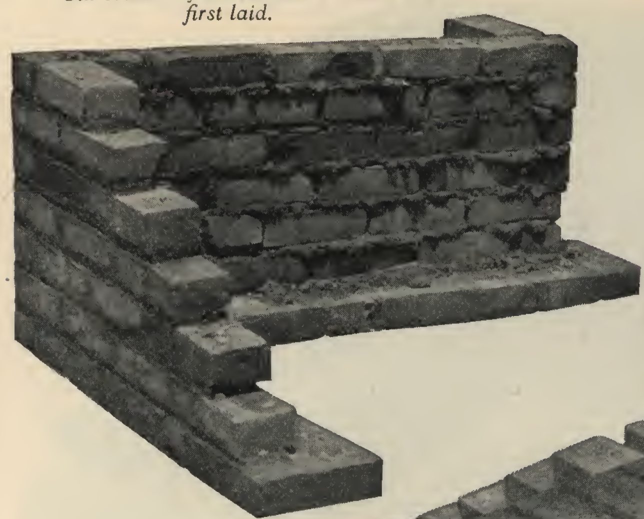
12. The continuous header course is shown in these illustrations, except in the standard 12″ wall.

13. The header course tying the two withes of the backing together in the 12″ heavy duty wall is shown as a continuous header course on edge as this provides maximum strength.

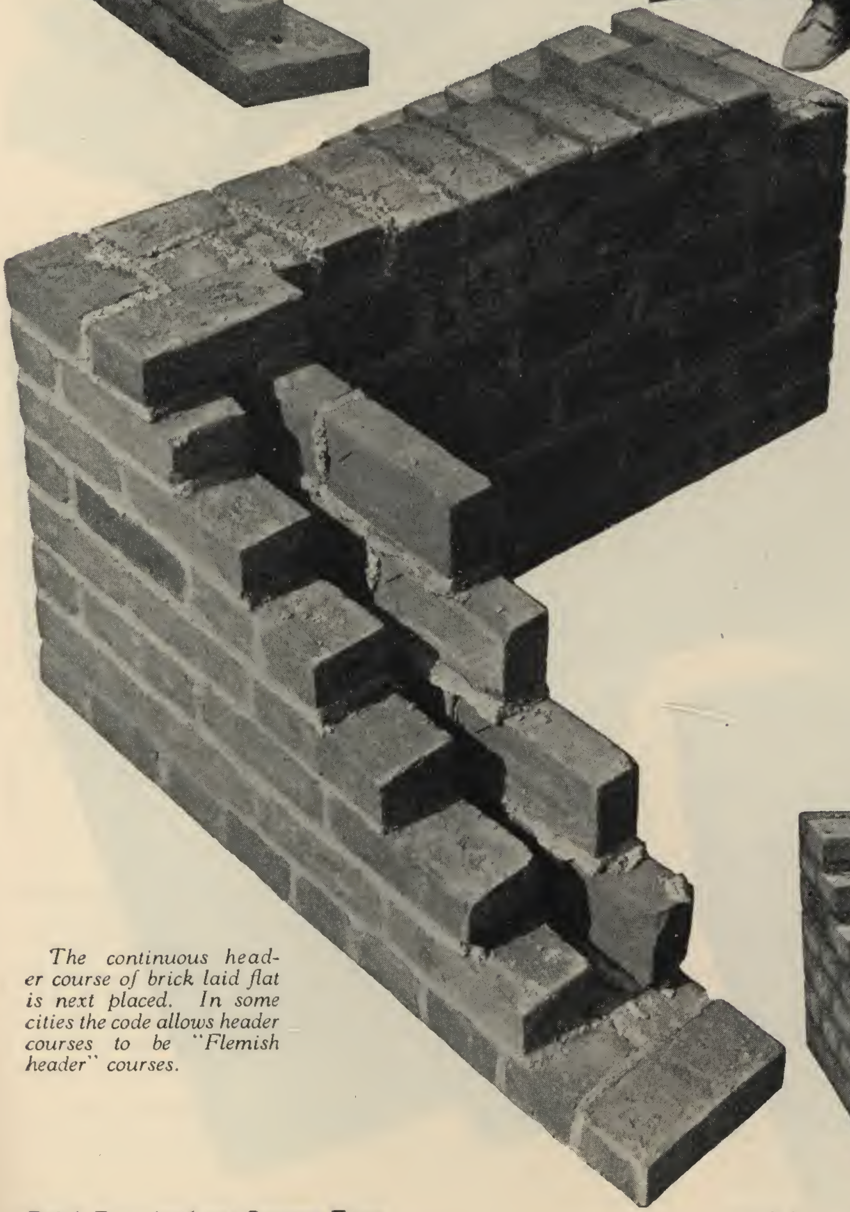
CONSTRUCTION OF THE 8" ROLOK-BAK WALL

(See paragraphs 14 to 18)

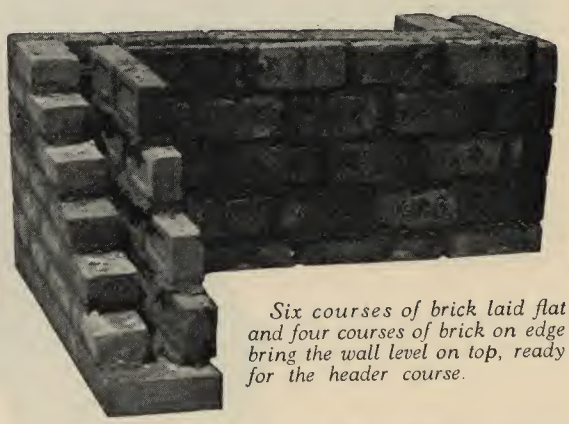
Six courses of the outside 4" withe are first laid.



Backing up with the inside "withe" of brick on edge. Note how easy and simple it is to build this sturdiest type of back-up construction.



The continuous header course of brick laid flat is next placed. In some cities the code allows header courses to be "Flemish header" courses.



Six courses of brick laid flat and four courses of brick on edge bring the wall level on top, ready for the header course.

Brick Required per Square Foot:

7 exposed brick (for 4" withe and headers), 3½ backing brick (for 2¼" withe). Total 10½ brick.

Weight:

With brick at 4½ lb. each and including mortar, backing weighs about 25 lb. per square foot and facing about 39 lb. per square foot.

Cost of Brick per Square Foot:

Take cost of brick per thousand in dollars, call dollars cents, and divide by 10. Result is cost of each brick in cents. Multiply result by number of brick to the square foot as given in opposite column.

Examples: Brick at $12 per thousand cost 1.2 cents each; at $20, 2 cents each. Square foot cost of brick in backing at $12 per thousand, 3.5x1.2=4½ cents; at $20 per thousand, 3.5x 2=7 cents.

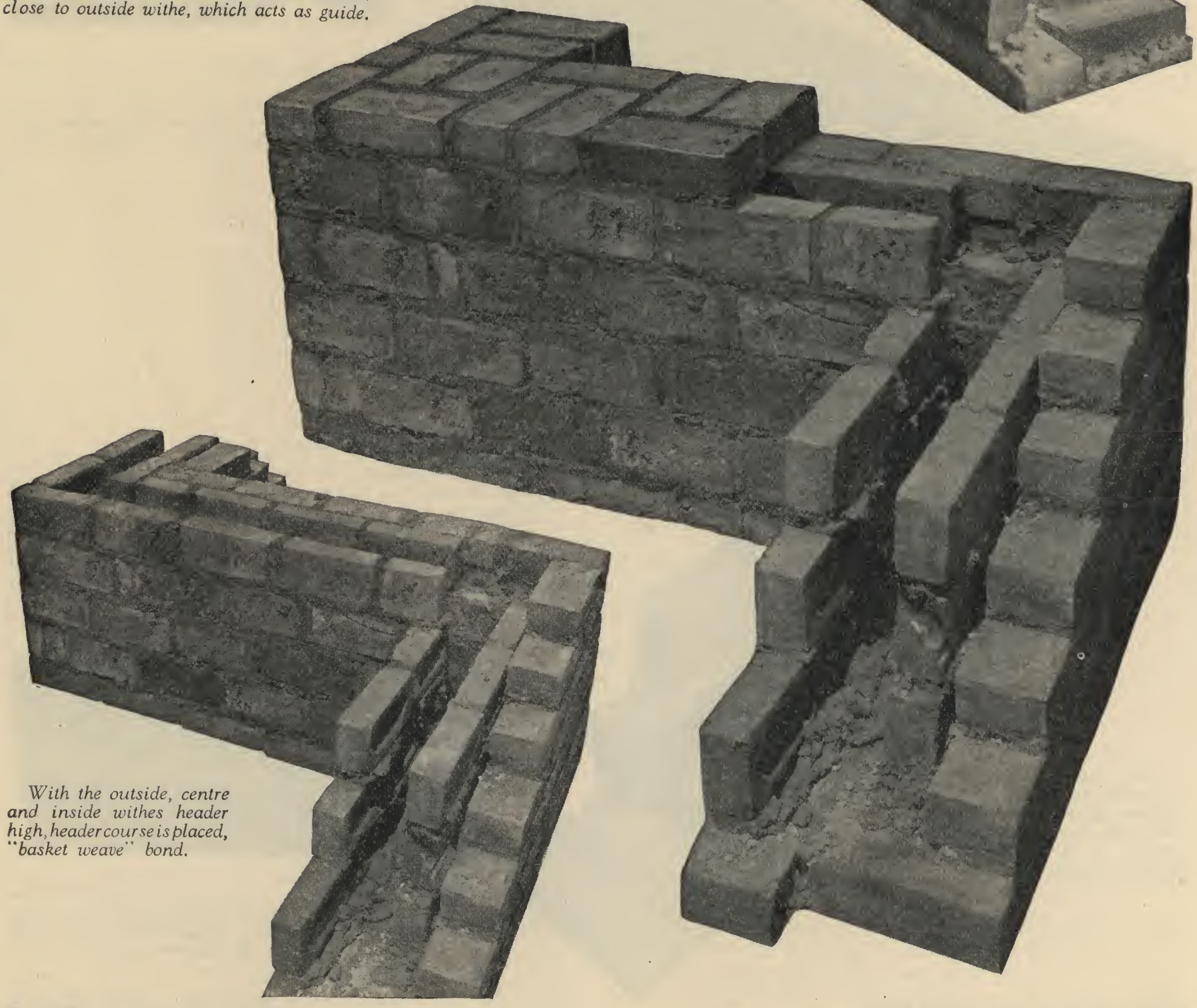
Labor Cost:

In walls with usual number corners and openings, safely estimate that a mason will lay 85.7 sq. ft. per day in carefully faced work. Laborer's time ⅔ mason's. In rougher work 135.7 sq. ft. per day with laborer's time ¾ mason's.

CONSTRUCTION OF THE 12" STANDARD ROLOK-BAK WALL

(*See paragraphs 19 to 28*)

After building outside withe six courses high (brick laid flat), mason builds centre and inside withes same height with four courses brick on edge. Centre withe is built close to outside withe, which acts as guide.



With the outside, centre and inside withes header high, header course is placed, "basket weave" bond.

Brick Required per Square Foot:

6.6 exposed brick (for 4" withe and headers), 8.4 backing brick (for 2¼" withes.) Total 15 brick.

Weight:

With brick at 4½ lb. each and including mortar, backing weighs about 50 lb. per square foot and facing about 39 lb. per square foot.

Cost of Brick per Square Foot:

Take cost of brick per thousand in dollars, call dollars cents, and divide by 10. Result is cost of each brick in cents. Multiply result by number of brick to the square foot as given in opposite column.

Examples: Brick at $12 per thousand cost 1.2 cents each; at $20, 2 cents each. Square foot cost of brick in backing at $12 per thousand, 8.4x1.2=10 cents; at $20 per thousand, 8.4x2=16.8 cents.

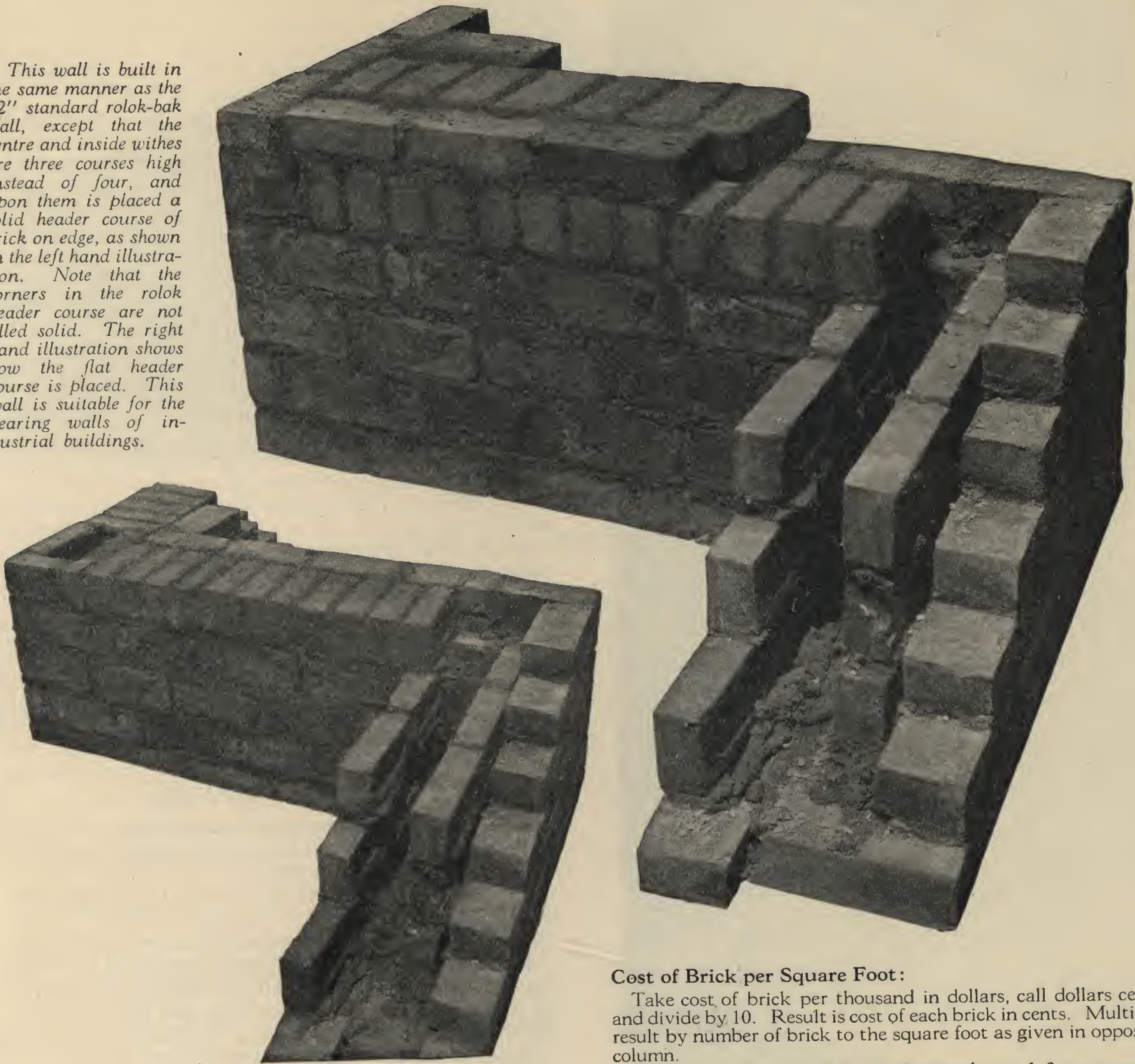
Labor Cost:

In walls with usual number corners and openings, safely estimate that a mason will lay 72.7 sq. ft. per day in carefully faced work. Laborer's time ⅔ mason's. In rougher work 108.3 sq. ft. per day with laborer's time ¾ mason's.

CONSTRUCTION OF THE 12" HEAVY DUTY ROLOK-BAK WALL

(*See paragraphs 29 to 37*)

This wall is built in the same manner as the 12" standard rolok-bak wall, except that the centre and inside withes are three courses high instead of four, and upon them is placed a solid header course of brick on edge, as shown in the left hand illustration. Note that the corners in the rolok header course are not filled solid. The right hand illustration shows how the flat header course is placed. This wall is suitable for the bearing walls of industrial buildings.



Brick Required per Square Foot:

7 exposed brick (for 4" withe and headers), 8.8 backing brick (for 2¼" withe). Total 15.8 brick.

Weight:

With brick at 4½ lb. each and including mortar, backing weighs about 56.5 lb. per square foot and facing about 39 lb. per square foot.

Cost of Brick per Square Foot:

Take cost of brick per thousand in dollars, call dollars cents and divide by 10. Result is cost of each brick in cents. Multiply result by number of brick to the square foot as given in opposite column.

Examples: Brick at $12 per thousand cost 1.2 cents each; at $20, 2 cents each. Square foot cost of brick in backing at $12 per thousand, 8.8x1.2—10.5 cents; at $20 per thousand, 8.8x 1.2=10.5 cents; at $20 per thousand, 8.8x2=17.6 cents.

Labor Cost:

In walls with usual number corners and openings, safely estimate that a mason will lay 68.5 sq. ft. per day in carefully faced work. Laborer's time ⅔ mason's. In rougher work 92.8 sq. ft. per day with laborer's time ¾ mason's.

Constructing the 8" Wall:

14. The bricklayer first lays six flat courses on the outside face of the wall. He then lays four courses on edge to form the inside withe. Six flat courses equal four courses on edge in height. He then places the header course.

Material and Labor Required, 8" Wall:

15. This wall requires 7 exposed brick and 3½ backing brick per square foot.

16. In walls with the average number of openings and corners, the contractor can safely and conservatively estimate that in front and other walls carefully faced, each mason will lay 600 exposed brick backed up with 300 backing brick per day in this wall, or a total of 900 brick per day; and for rougher work in side and rear walls and in unexposed walls each mason will lay 950 exposed brick backed up with 475 backing brick per day, or a total of 1,425 brick per day.

17. This equals 85.7 sq. ft. per day for carefully faced work, and 135.7 sq. ft. per day for rougher work.

18. Laborer's time should be figured at ⅔ of the bricklayer's time for carefully faced work, and ¾ for rough work.

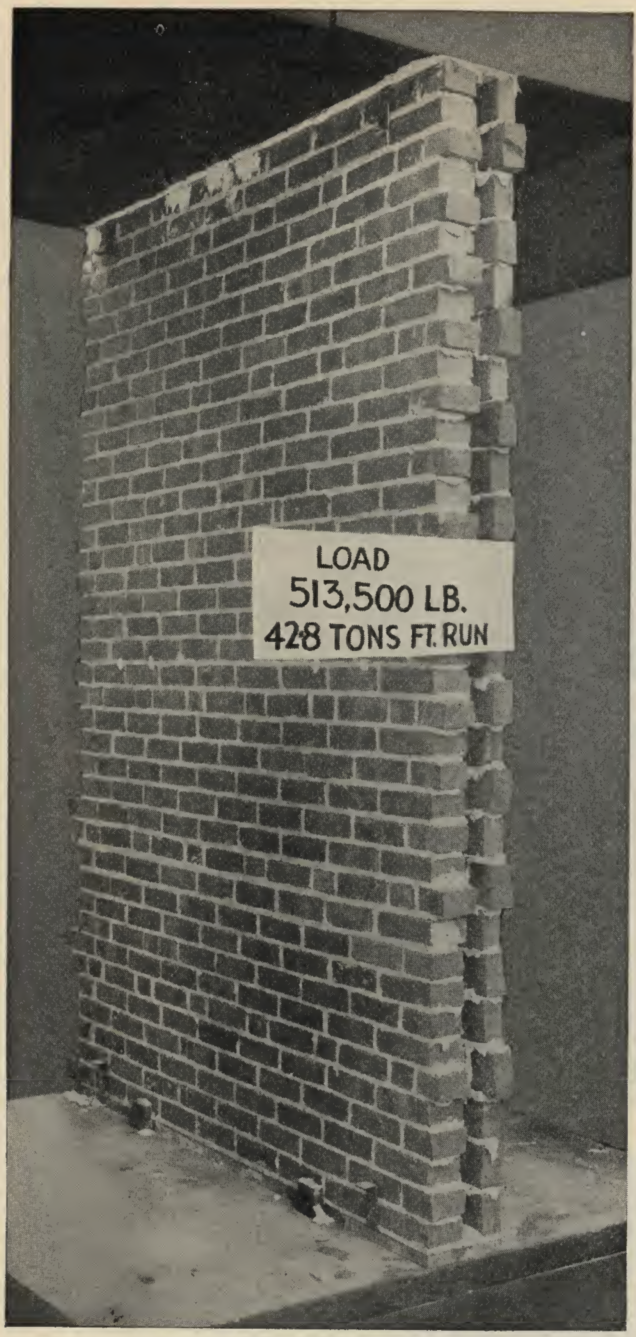


Figure 7. A preliminary private test on an 8″ rolok-bak wall, built of brick with about 5,000 lbs. per square inch crushing strength, laid in 1:1:6 cement-lime mortar. Specimen, about 9 feet high, sustained a total load of 45 tons per foot run or 936 lb. per square inch of gross area of wall when only 30 days old. Photograph taken when load had reached 42.8 tons per foot run or 891 lb. per square inch gross area. This wall is a variation of the wall here recommended. It is built with "Flemish header" bond courses instead of continuous headers, and the latter make an even stronger wall.

Constructing the 12″ Standard Wall:

19. The six flat courses outside are first placed as for the 8″ wall.

20. The centre and inside withes are then built together according to the ordinary practice in the backing of brickwork, each four courses high.

21. The brick for the centre withe are placed against the back of the outside 4″ withe, which thus forms a guide for the centre withe. No mortar is placed in the vertical joint between the outside and the centre withes.

22. Although the pictures show the end joints in the centre withe full of mortar, it is necessary only to see that the bed joints are full, the brick being placed two at a time by the bricklayer—one in each hand—upon the bed of mortar previously spread. The labor necessary for the centre withe is thus very much less than for the inner withe.

23. Then place the flat header course to tie the wall together. It is suggested that this course be backed up as each 8″ length is placed. The headers are laid "basket weave" fashion, one pair of headers being placed at the face of the wall, backed up by a stretcher; then a stretcher is placed at the face of the wall, backed by a pair of headers.

24. It is important to stagger the position of the pairs of exposed headers with respect to their position in the header course immediately below.

Material and Labor Required, 12″ Standard Wall:

25. This wall requires 6.6 exposed brick and 8.4 backing brick per square foot.

26. In walls with the average number of openings and corners, the contractor can safely and conservatively estimate that in front and other walls carefully faced, each mason will lay 480 exposed brick backed up with 610 backing brick per day in this wall, or a total of 1,090 brick per day; and for rougher work in side and rear walls and in unexposed walls each mason will lay 715 exposed brick backed up with 910 backing brick per day, or a total of 1,625 brick per day.

27. This equals 72.7 sq. ft. per day for carefully faced work, and 108.3 sq. ft. per day for rougher work.

28. Laborer's time ⅔ of the bricklayer's time for carefully faced work, and ¾ for rougher work.

Building the 12″ Heavy Duty Wall:

29. This wall is constructed exactly like the standard wall except that the centre and inside withes are built only three courses high.

30. Next place the header course tying these two withes together.

31. This is a continuous course of rowlock headers.

32. The brick in this header course need not have the vertical joints between them filled with mortar. As with the centre withe, see that the bed joints are full, and that the vertical joint is filled to a distance of about one inch from the inside face of the wall.

33. Then the flat header course is placed, consisting of a continuous header course on the outside face with a course of stretchers behind it.

Material and Labor Required, 12″ Heavy Duty Wall:

34. This wall requires 7 exposed brick and 8.8 backing brick per square foot.

35. In walls with the average number of openings and corners, the contractor can safely and conservatively estimate that in front and other walls carefully faced, each mason will lay 480 exposed brick backed up with 603 backing brick per day in this wall, or a total of 1,083 brick per day; and for rougher work in side and rear walls and in unexposed walls each mason will lay 650 exposed brick backed up with 817 backing brick per day, or a total of 1,467 brick per day.

36. This equals 68.5 sq. ft. per day for carefully faced work, and 92.8 sq. ft. per day for rougher work.

37. Laborer's time ⅔ of the bricklayer's time for carefully faced work, and ¾ for rougher work.

Figure 8. Variation of Ideal wall all-rolok effect. Business building in Chicago.

THE ALL-ROLOK WALL

General Description:

38. The all-rolok wall is a general utility wall; and may be employed for exposed and unexposed walls, both bearing and non-bearing, and for basement construction. It forms a perfect base for stucco where a stucco finish is particularly desired; and for plaster where used as an interior wall.

39. The attention of architects and structural engineers is especially drawn to this wall on account of its low cost and light weight, and the opportunity it affords (in common with the rolok-bak wall) for impressive savings in the amount of steel required to support the exterior or interior walls of a skeleton frame building.

40. The wall is built with two courses entirely of stretchers on edge, alternating with one course of flat headers. To the architectural designer it offers opportunities for new and interesting effects.

41. No other form of masonry construction 8″ or more in thickness, can compete with this wall in low cost, not only for exposed walls but also for basement and unexposed walls, such as enclosing walls around stairways, etc.

42. This wall also has the great advantage of exposing to the weather not only a minimum thickness of 2¼″ of solid brick units in its outside withe, but in addition both horizontal and perpendicular exposed mortar joints have the same solid thickness.

43. Because this wall combines the advantages of low labor cost and minimum amount of material for a hollow wall and reduced weight, we predict that it will become increasingly popular. Practical masons know that its flat header courses and continuous stretcher courses are laid very rapidly. The wall may be built 8″ thick and in multiples of 4″ additional thicknesses.

Position of the Header Course:

44. Placing the headers every third course as shown in the illustrations gives an interesting effect to an exposed wall, develops maximum strength, and expedites the construction in cold or wet weather or where an impervious type of brick is used.

45. When light loads only are to be supported, and when a brick with average absorption is used, one or two additional courses on edge may be placed safely between header courses.

Constructing the 8″ Wall:

46. The bricklayer first lays two courses of continuous stretchers to form the outside withe; and then two courses of continuous stretchers to form the inside withe. He then places the flat header course.

Material and Labor required, 8″ Wall

47. This wall requires 9 brick per square foot, of which 6 brick are exposed in outside walls.

48. In walls with the average number of openings and corners, the contractor can safely and conservatively estimate that each mason will lay 1,000 brick per day in front and other walls carefully faced, and 1,150 brick per day for rougher work in side and rear walls and unexposed walls.

49. This equals 111.1 sq. ft. per day for carefully faced work, and 127.7 sq. ft. per day for rougher work.

50. Laborer's time ⅔ of the bricklayer's time for carefully faced work, and ¾ for rougher work.

Constructing the 12″ Wall:

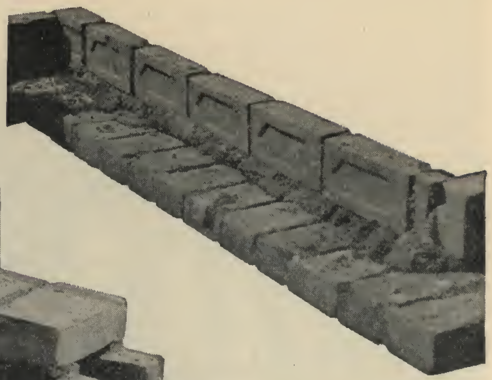
51. The three withes are constructed, each two courses high. The header course consists of pairs of headers laid flat, basket weave bond, with a stretcher placed alternately on the inside and outside of the wall.

52. The centre withe is not placed in the centre of the wall, but at the end of the headers which show on the outside face of the wall. Toward the outside of the wall, therefore, the air space is approximately 3½″ wide, and the air space toward the inside of the wall about 2″ wide.

53. The same suggestions are made as to the building of the centre withe and the placing of the header course as in the case of the 12″ standard rolok-bak wall. (Pars. 22 and 23 of this section)

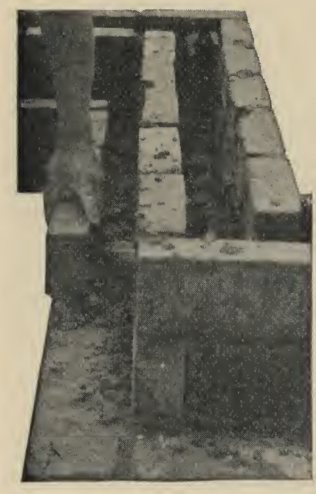
CONSTRUCTION OF THE 8" AND 12" ALL-ROLOK WALL

(*See paragraphs 38 to 57*)

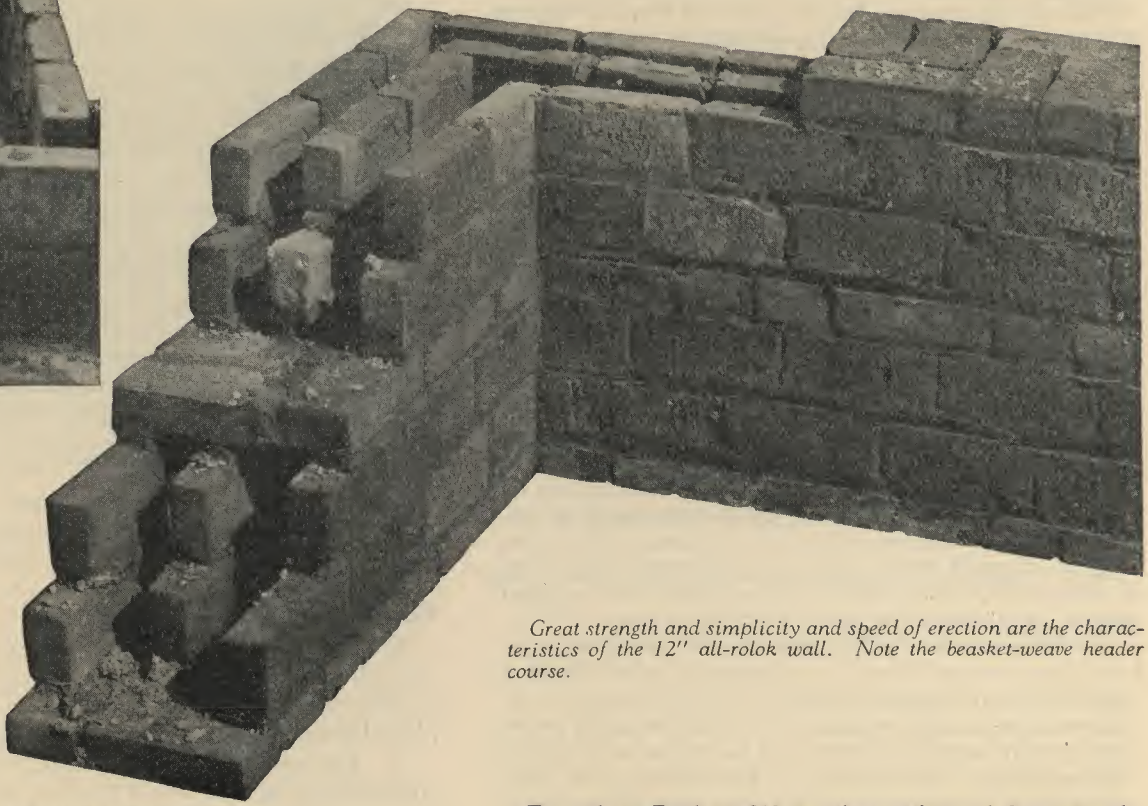


Starting the 8″ wall on the header.

Note the simplicity of this sturdy wall—two continuous courses of stretchers, front and back, followed by the header course.



The centre withe is not centered in the wall, but is lined up at ends of outside headers.



Great strength and simplicity and speed of erection are the characteristics of the 12″ all-rolok wall. Note the beasket-weave header course.

Brick Required per Square Foot:

For 8″ wall—9; for 12″ wall 13.5 of which 6 are exposed

Weight:

With brick at 4½ lb. each and including mortar, 8″ wall weighs about 51.5 lb. and 12″ wall about 77.25 lb. per square foot.

Cost of Brick per Square Foot:

Take cost of brick per thousand in dollars, call dollars cents, and divide by 10. Result is cost of each brick in cents. Multiply result by number of brick to the square foot as given above.

Examples: Brick at $12 per thousand cost 1.2 cents each; at $20, 2 cents each. Square foot cost of brick is 10.8 cents and 18 cents respectively for 8″ wall; and 16.2 cents and 27 cents respectively for 12″ wall.

Labor Cost:

In walls with usual number corners and openings, safely estimate that a mason will lay, with the 8″ wall, 111.1 sq. ft. per day in carefully faced work. Laborer's time ⅔ mason's. In rougher work 127.7 sq. ft. per day. Laborer's time ¾ mason's.

With 12″ wall, 80 sq. ft. per day in carefully faced wall; laborer's time ⅔ mason's; in rougher work 118.5 sq. ft. per day, laborer's time ¾ mason's.

Figure 9. House of all-rolok construction in Flemish bond at Lansdowne, Pa.

Material and Labor Required, 12″ Wall:

54. This wall requires 13½ brick per square foot, of which 6 brick are exposed per square foot in outside walls.

55. In walls with the average number of openings and corners, the contractor can safely and conservatively estimate that each mason will lay 1,080 brick per day in front and other walls carefully faced, and 1,600 brick per day for rougher work in side and rear walls and unexposed walls.

56. This equals 80 sq. ft. per day for carefully faced work, and 118.5 sq. ft. per day for rougher work.

57. Laborer's time equal to ⅔ of the bricklayer's time for carefully faced work, and ¾ for rougher work.

THE ALL-ROLOK WALL—FLEMISH BOND

General Description:

58. This wall is primarily intended for exposed walls. It is very strong construction, however, and is much used for basement work, and for interior walls.

59. It is constructed entirely of brick on edge laid in Flemish bond for the outside 8″ thickness. For thicker walls a withe of stretchers on edge is added for each additional 4″ thickness.

60. The all-rolok wall previously described in pars. 38 to 57 corresponds roughly to traditional brickwork laid in common bond, and the all-rolok wall in Flemish bond here described corresponds to traditional brickwork in Flemish bond. With Flemish bond, whether flat or on edge, the labor cost is higher than with the simpler bonds such as common bond or the all-rolok wall because the latter can be built more rapidly. The Detroit Bricklayer's Union recently stated, however, that a bricklayer can easily lay 1,000 brick per day with this type of wall 8″ thick. It requires the minimum amount of material.

61. This was the first brick on edge wall to be introduced and promoted some five years ago, and is still mistakenly understood by many to be the only type of Ideal construction.

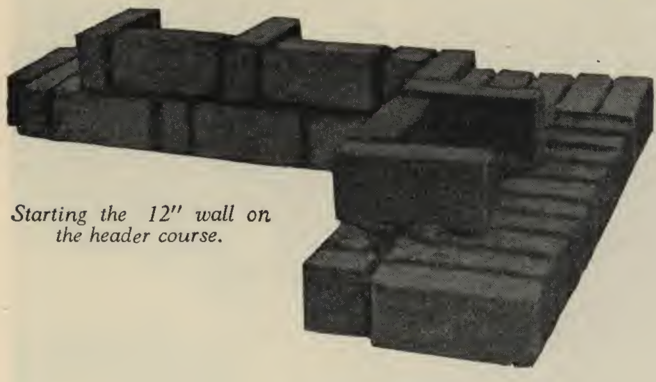
62. Its success has been phenomenal. Homes, churches, schools and industrial buildings have been constructed with this wall.

Appearance:

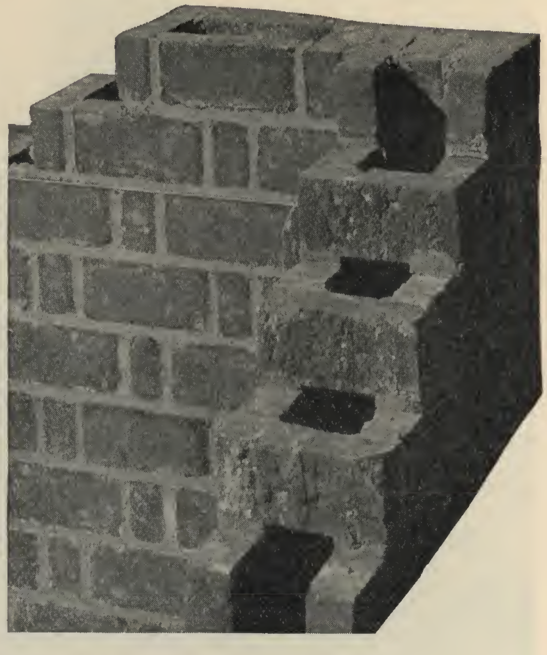
63. The exposed face of the Flemish bond all-rolok wall has a surprisingly distinctive appearance. Where the rough or wire cut surface of the stretchers is exposed in combination with the smooth end of the headers this produces an effective and charming appearance.

CONSTRUCTION OF THE 8" AND 12" ALL-ROLOK WALL IN FLEMISH BOND

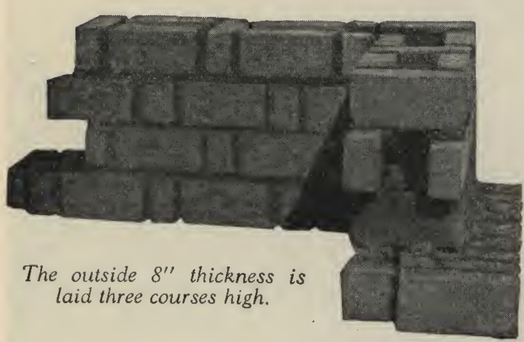
(*See paragraphs 58 to 79*)



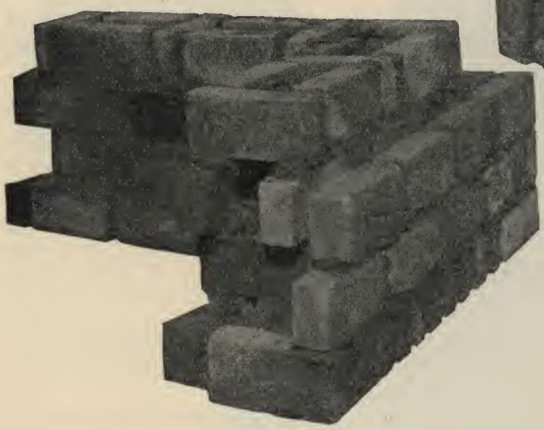
Starting the 12" wall on the header course.

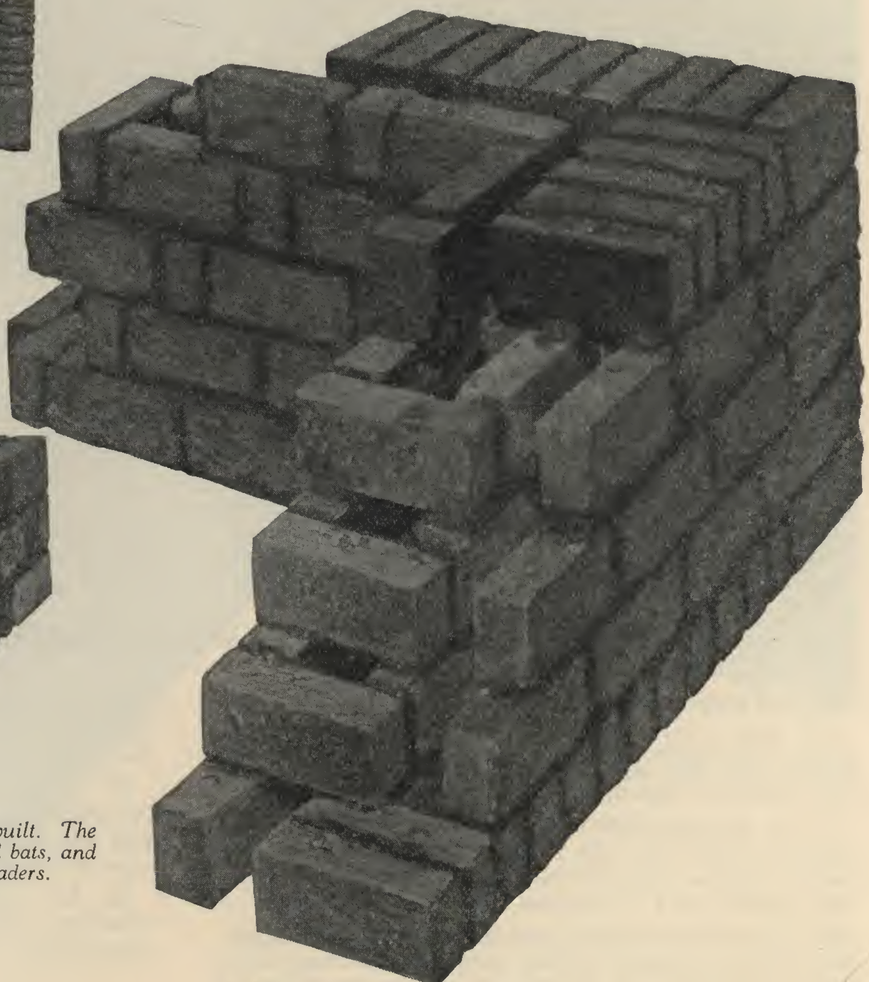


This wall is known throughout the country. Tremendously strong construction entirely of brick on edge.



The outside 8" thickness is laid three courses high.





Three courses entirely of stretchers are then built. The next course of facing consists of stretchers and bats, and the backing a continuous course of rowlock headers.

Brick Required per Square Foot:

For 8" wall, 9; for 12 wall, 13.75; of which 6 are exposed.

Weight:

This wall has approximately the same weight as the all-rolok wall (page 14).

Cost of Brick per Square Foot:

Is approximately the same as for the all-rolok wall, the 12" wall only having ¼ brick additional per sq. ft.

Labor Cost:

In walls with usual number corners and openings, safely estimate that a mason will lay, with the 8" wall, 72.2 sq. ft. per day. Laborer's time ½ mason's.

With the 12" wall, 58.1 sq. ft. per day in carefully faced wall, laborer's time ½ mason's; in rougher work 72.7 sq. ft. per day, laborer's time ½ mason's.

Before passing on the appearance of this wall, lay up half a dozen courses or inspect a sample wall. Whenever judgment is based upon a sample or an actual wall there is no further question as to its beauty.

Figure 10. All-rolok wall in Flemish bond. Building near Baltimore

Building the 8″ Wall:

64. The wall is built by laying headers and stretchers alternately, and backing up at every course.

65. The headers in each course are placed over the centre of the stretchers of the course below.

66. The 8″ thickness of this wall must be laid "pick and dip" fashion and hence is slower to lay than the other types of Ideal wall.

Material and Labor Required, 8″ Wall:

67. In walls with the average number of openings and corners, the contractor can safely and conservatively estimate that each mason will lay 650 brick per day with this wall.

68. This equals 72.2 sq. ft. per day.

69. Laborer's time ½ of the bricklayer's time

Building the 12″ Wall:

70. The outside 8″ thickness is built as above, three courses high.

71. One course is then placed on the outside withe consisting of stretchers and bats alternately, the bats being used to preserve the bond.

72. The inside withe is then built three courses high entirely of stretchers.

73. A solid header course of brick on edge is then placed to tie the inside withe to the outside 8″ thickness.

74. When building the outside 8″ thickness, a 4″ shelf is left inside on which the mason can store up brick. This partly eliminates the "pick and dip" method which is necessary when the completed wall is to be 8″ thick, and consequently allows the mason to lay more brick per day.

75. The same suggestions are made as to the mortar joints in the solid header course as in the case of the solid header course in the heavy duty rolok-bak wall (par. 32 of this section).

Material and Labor Required, 12″ Wall:

76. This wall requires 13.75 brick per square foot, of which 6 brick are exposed in outside walls.

77. In walls with the average number of corners and openings, the contractor can safely and conservatively estimate that each mason will lay 800 brick per day in front and other walls carefully faced, and 1,000 brick per day for rougher work in side and rear walls and unexposed walls.

78. This equals 58.1 sq. ft. per day for carefully faced work, and 72.7 sq. ft. per day for rougher work.

79. Laborer's time equal to ½ of the bricklayer's time.

GENERAL CONSTRUCTION DATA ON HOLLOW WALLS

Supporting Floors and Roofs:

1. Floor joists and roof construction should rest directly upon a header course. In most cases the header course can be made to come at the exact height required. If not, the header course can simply be brought up as nearly as possible to that height, the remaining height to the bottom of the joists being filled in with the necessary number of courses of solid brickwork to give the joists a firm bearing.

2. Setting the joists upon a header course also provides an effective firestop.

Anchors:

3. While the necessity for using anchors to form a positive tie between floor and roof timbers and the masonry is no greater with the Ideal wall than with any other type of masonry construction, the use of such anchors is emphatically recommended by this Association. It is realized that the practice of using such anchors is more honored in the breach than in the observance; but when some natural calamity such as a tornado visits a community, it has been repeatedly shown that buildings in which anchors and other features of good construction have been conscientiously used come through practically unscathed. Small portions of the Ideal wall in which anchors are to be embedded can easily be made solid. In addition to anchoring floors and roofs, it is recommended that parapet walls be also substantially anchored to the construction.

Earthquake Construction:

4. It should be pointed out that in earthquake zones anchors are vital to the safety of the building. Girders, joists and roof timbers should be anchored securely to the brick walls. Buildings so constructed will withstand earthquake shocks without serious structural damage.

Window and Door Sills and Jambs:

5. Window and door sills (brick on edge or stone) are placed, and the frames set, plumbed and braced upon them in the ordinary way; exactly as with the solid wall.

6. The frames are bricked in at the jambs also, exactly as with the solid wall.

7. Although not necessary for strength, it is recommended that the portion of the hollow space or spaces adjacent to the frame be filled for a width of 3″ or 4″ with brickbats to provide firestopping and draft stopping.

8. Exposed brick may be supported over openings by either of the usual methods of using lintels or arches.

9. For openings not exceeding the usual window or door widths, follow the same method employed in solid brick construction—that of placing 4″ x 4″ or 4″ x 6″ wood lintels to support the backing. The lintels have a 4″ bearing on the brickwork at each end. Brickwork either flat or on edge will arch itself over such an opening even after the wood lintel shrinks or is entirely destroyed by fire.

10. For wider openings the backing may be supported on a steel lintel of proper size to support the load; or a wood lintel may be employed with a relieving arch over. A small portion of the brickwork at the spring line can be made solid to take the thrust, or the arch can spring from a header course. The space between the top of the wood lintel and the bottom of the relieving arch is bricked in with brick on edge; the top of the brickwork being roughly shaped to the proper curve and forming a centre for the relieving arch.

11. It should be emphasized that the foregoing methods are the traditional and ordinary methods of carrying brickwork over openings; and that the Ideal wall introduces nothing new or unusual in this portion of the construction.

12. Mortar should be slushed over the top of wood window and door frames within the hollow space for the same purpose that the space is filled at the jambs — to provide fire and draft stopping.

Window and Door Frames:

13. Stock window and door frames in rolok-bak walls can have the same outside reveal and relation to the inside plaster line as in the case of the ordinary solid wall.

14. In the case of 8″ all-rolok walls, the outside reveal can be made $2\frac{1}{4}$″ wide—the width of a brick on edge. A piece of finish wood is placed between the inside face of the frame and the back of the trim at jamb and head as shown.

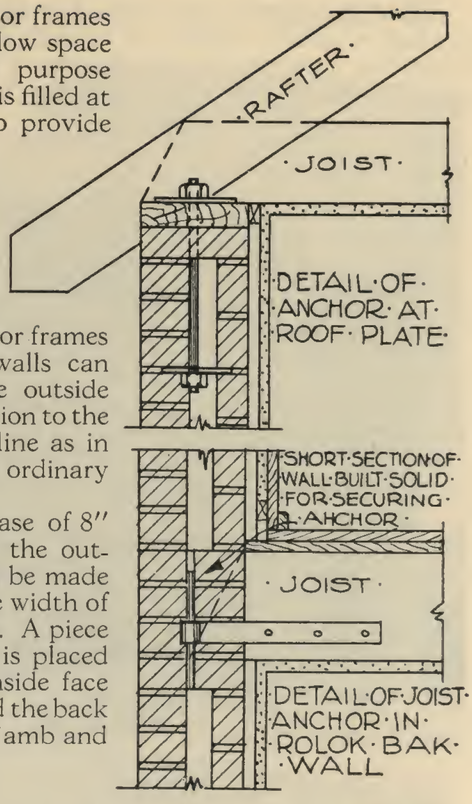


Figure 11. Anchors of any type can be built into Ideal walls and secured by constructing a small part of the wall solid.

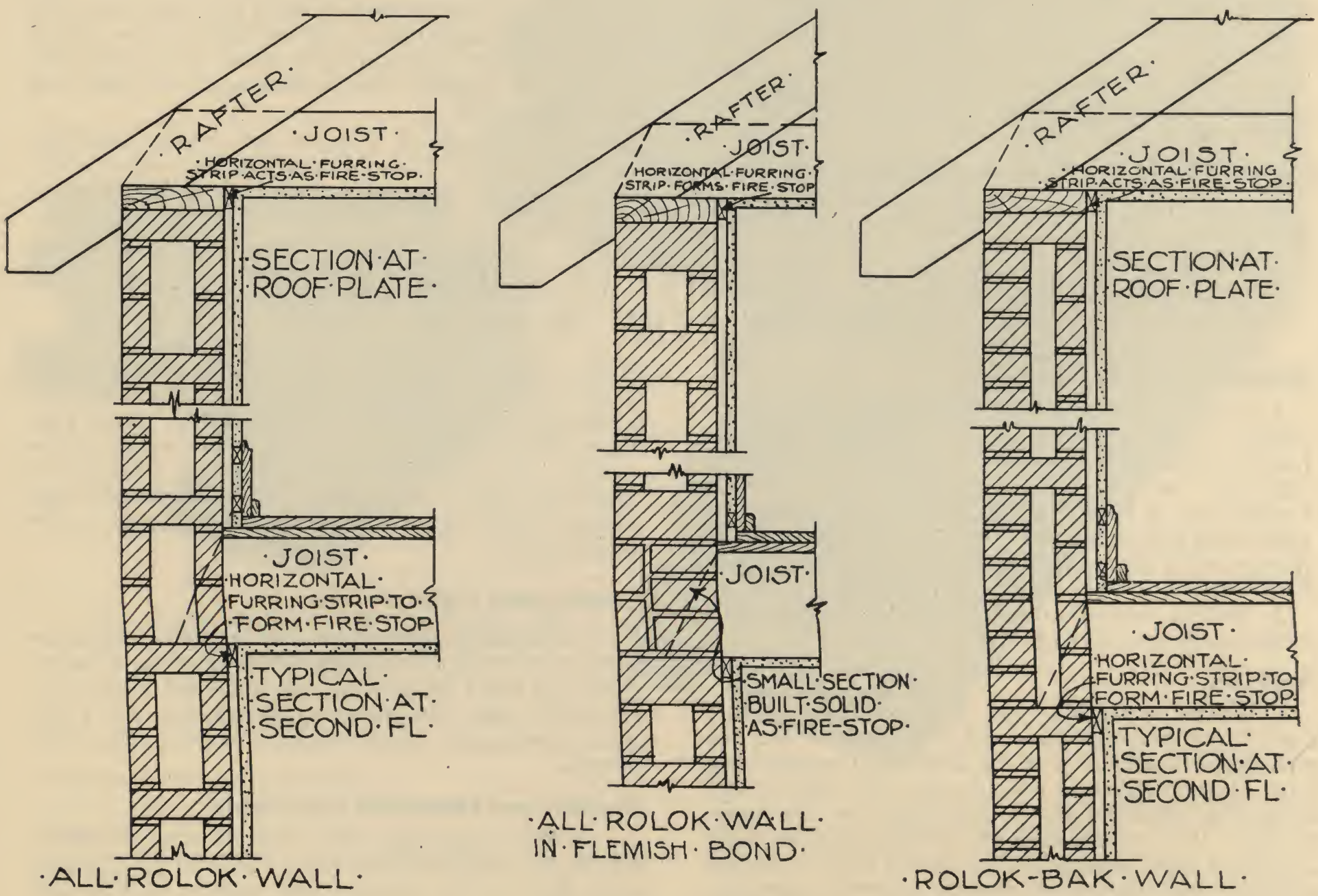
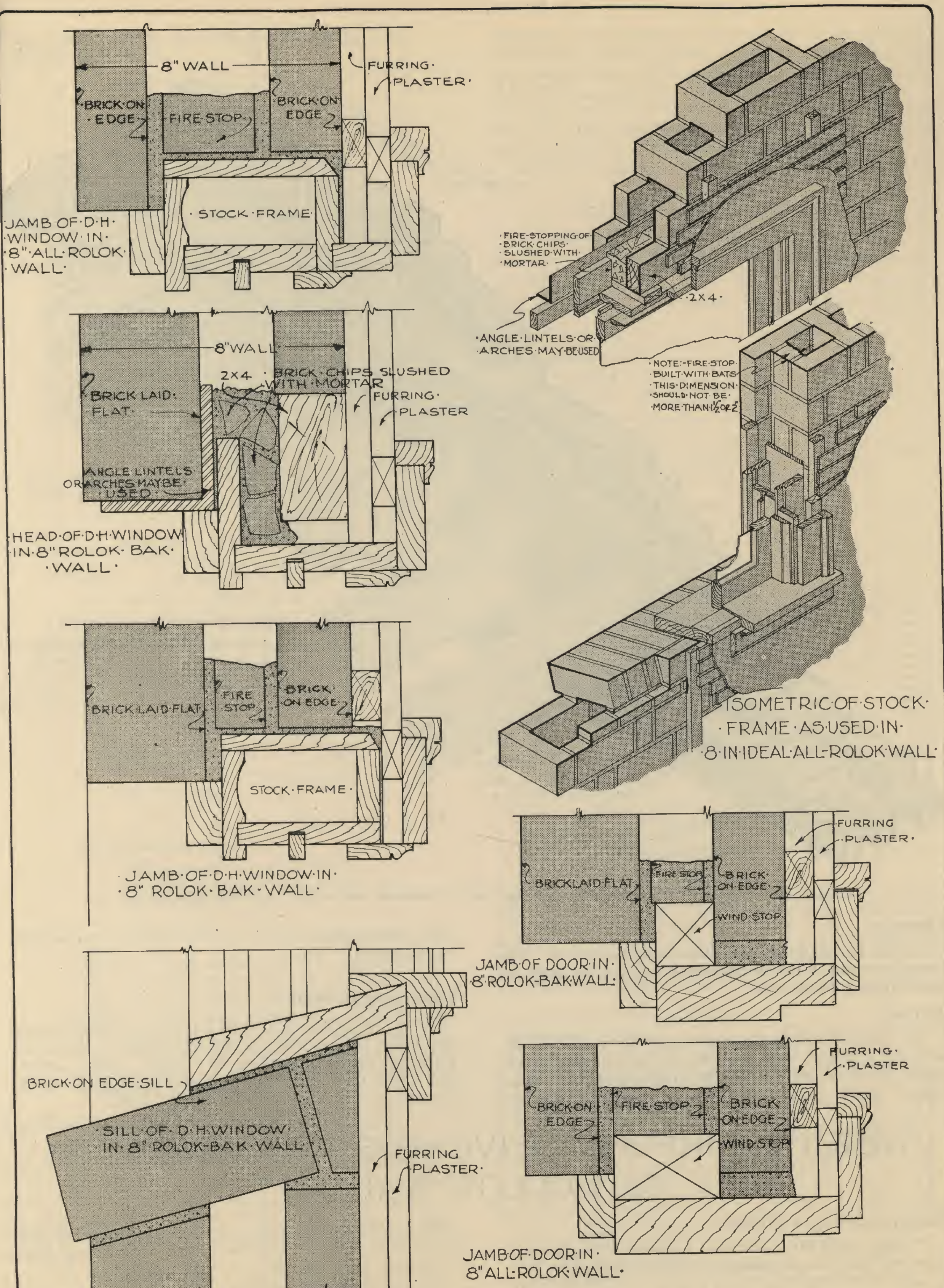


Figure 12. Details at floor and roof levels showing typical joist and roof supports.



DETAILS OF STOCK WINDOW FRAMES AS USED IN 8 IN IDEAL WALLS

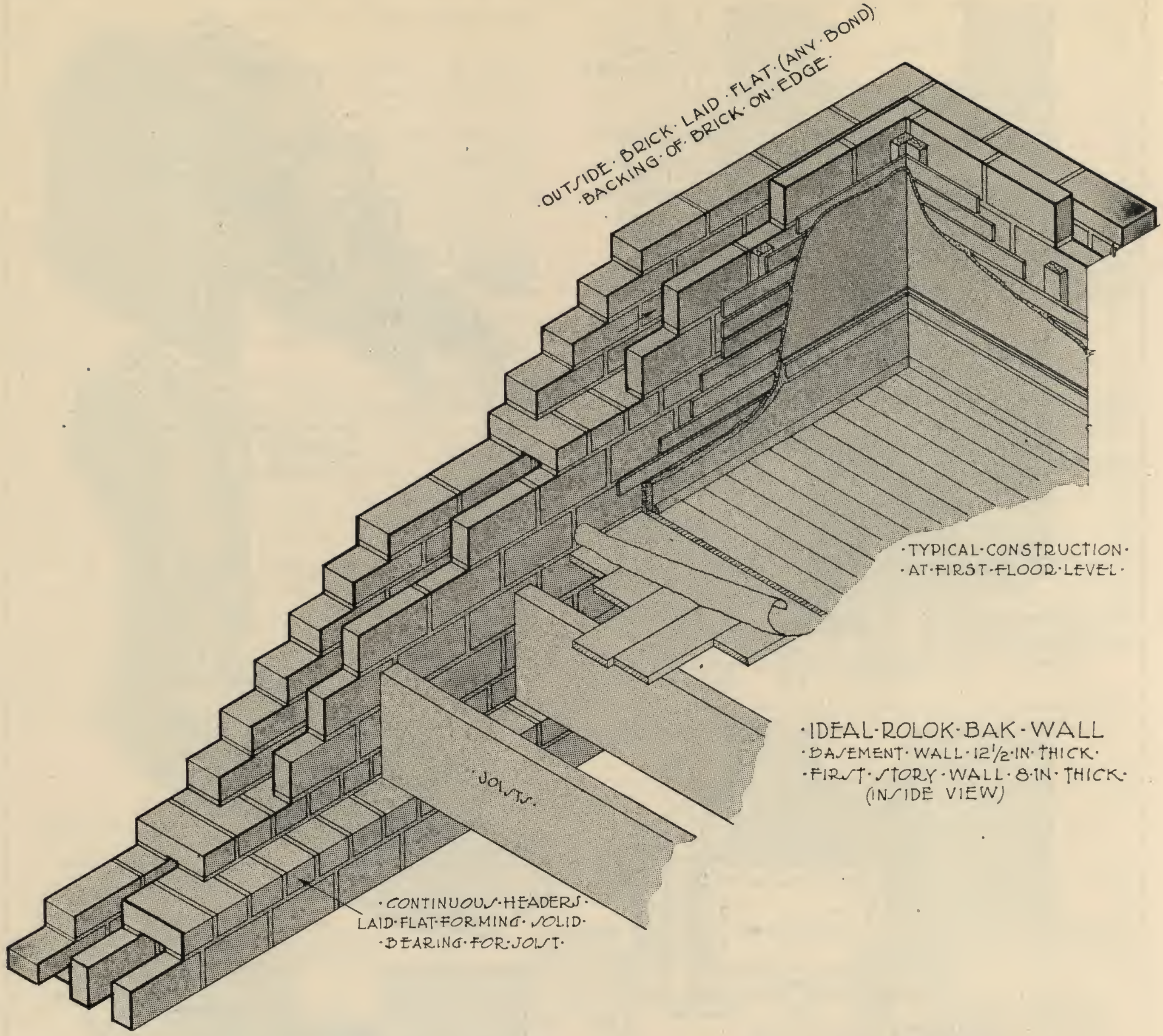


Figure 13. Typical construction detail at first floor level, 8″ rolok-bak wall with 12″ rolok-bak basement wall.

Mortar:

15. It is recommended that mortar of no less strength than 1:1:6 cement-lime mortar be used in constructing Ideal walls.

Joints:

16. Inasmuch as flush cut joints are quite commonly used for exposed walls, it is recommended that these joints be used also for side and rear walls, instead of struck joints. This will increase bricklayer production, and the figures given in this publication can then be increased.

Thickness of Walls:

17. In the absence of code regulation, the following minimum thicknesses are recommended. Basement walls for masonry houses, 12″ thick. First, second and third floor walls for masonry houses, 8″ thick. Basement walls for frame houses, 8″ thick.

WEIGHT, FIRE RESISTIVENESS AND STRENGTH OF HOLLOW WALLS

Weight of Hollow Walls:

1. Ideal walls are lighter per square foot than many types of hollow unit walls, and this is especially true in cases where building codes require thick webs or an extra number of webs in such hollow units. In these cases the Ideal wall saves considerable weight over hollow unit construction. This allows large savings where Ideal walls are used as curtain walls in buildings of skeleton construction.

2. One important element of lightness is the fact that Ideal walls require the minimum amount of mortar per square foot of wall.

Weight per Square Foot of Backing Only of Rolok-Bak Walls:

8″ rolok-bak wall:

4.4 brick (including back of headers) at 4½ lb. . . . . .19.8 lb.
61 cu. in. mortar. . . . 5.3 lb.

Weight of backing only about. . . . . . . .25.1 lb. per sq. ft.

12″ standard rolok-bak wall:

8.9 brick (including back of headers) at 4½ lb. . . . . .40.0 lb.
113 cu. in. mortar. . . .10.0 lb.

Weight of backing only about. . . . . . . .50.0 lb. per sq. ft.

12″ heavy duty rolok-bak wall:

9.7 brick (including back of headers) at 4½ lb. . . . . .43.5 lb.
150 cu. in. mortar. . .13.0 lb.

Weight of backing only about. . . . . . . .56.5 lb. per sq. ft.

NOTE:— The weight of the 4″ brick facing only, including 6⅛ brick at 4½ lb. and 128 cu. in. mortar, totals about 39 lb. per sq. ft.

Weight per Square Foot of All-Rolok Walls:

The weight of all-rolok walls, whether in Flemish or stretcher bond, works out about the same per square foot of wall.

8″ all-rolok wall:

9 brick at 4½ lb. . . . .40.5 lb.
127 cu. in. mortar . . .11.0 lb.

Total weight of wall about. . . . . .51.5 lb. per sq. ft.

12″ all-rolok wall:

13½ brick at 4½ lb.60.75 lb.
190 cu. in. mortar. .16.5 lb.

Total weight of wall about. . . . . .77.25 lb. per sq. ft.

NOTE:—When estimating the weight of hollow unit walls for comparison with the above, and including in the figures the weight of the mortar, and the portion of the header courses in the back of the wall, it will be found that the Ideal wall is lighter than the average wall or back-up construction of hollow units.

Fire Resistance of Ideal Wall Construction:

3. According to a recent issue of the *American Architect*, (from which the following data is compiled) the U. S. Bureau of Standards recently made fire tests upon brick masonry walls, including all-rolok walls in Flemish bond, 8″ and 12″ thick. (The detail of the latter thickness was a variation of the wall shown in this publication).

4. The test panels were 11 feet high—giving a very severe test, for it is seldom that walls of that height are built without the steadying action of intermediate floor construction. In addition, some of the specimens (denoted "Unrestrained") were entirely free-standing, without any lateral support whatever above the frame upon which they stood, except for pilasters at the ends of the 8″ panels, which were 16 feet long.

5. The walls were exposed to the temperatures defined by the standard temperature curve, which reaches 1,700° F. at the end of the first hour; 1,850° F. at two hours, with a uniform rise to 2,150° F. at six hours.

Ideal Wall Fire Test Results

(Compiled from U. S. Bureau of Standards report as published in *The American Architect*)

Test No.	Brick	Restraint	Unexposed Face of Wall: Time at which 482°F† was reached Hrs. Mins.	Unexposed Face of Wall: Temperature at 6 hrs. °F
	8″ WALLS			
4	Western surface clay	unrestrained*	not attained	419°(4 hrs.)
5	do.	restrained	not attained	453°
6	do.	restrained	5:58	484°
11	Eastern surface clay	unrestrained*	4:50	493°(5 hrs.)
16	Shale	unrestrained	5:03	522°
	Average for 8″ walls			486°
	12″ WALL			
12	Eastern surface clay	unrestrained	not attained	172°(5 hrs.)

* Tests less than six hours not included in averages.
† A temperature of 482° F is at or near the ignition point of a number of classes of combustible materials.

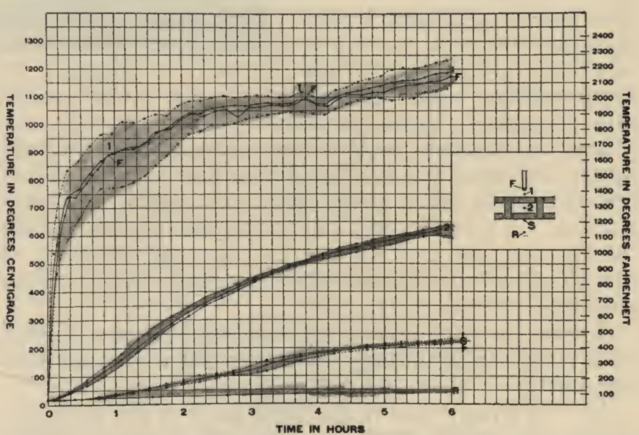


Figure 14. Graphic curves showing heat resistiveness of 8″ Ideal wall during fire tests at U. S. Bureau of Standards. The various curves starting from the left hand lower corner (F and I representing temperatures on furnace side of wall, Q the temperature inside the wall, S the temperature on the unexposed face of the wall and R the room temperature) all rise as the test progresses; the time elapsed being plotted horizontally and the temperature in degrees vertically.

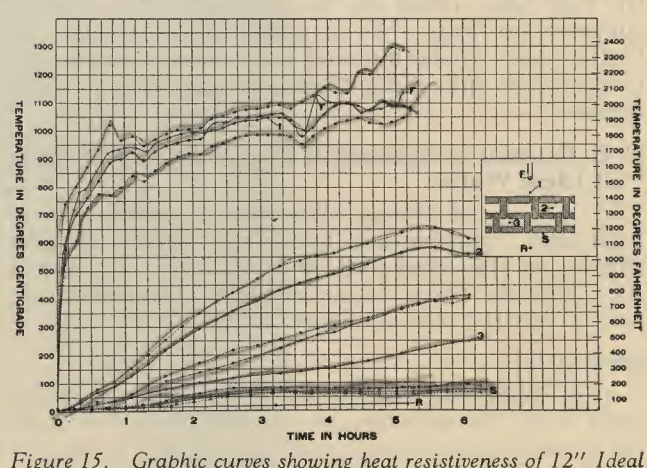


Figure 15. Graphic curves showing heat resistiveness of 12″ Ideal walls during fire tests at U. S. Bureau of Standards

6. The report states in part: "Careful examination of 8-inch and heavier walls after fire test indicated that the header bond provided by . . . . alternate headers and stretchers in the hollow walls was sufficient from the standpoint of resistance to fire to tie the stretcher brick, no general separations occurring."

U. S. Bureau of Standards Builds Ideal Wall Test Structure:

7. An authorized article in a recent issue of *Building Economy* states that the U. S. Bureau of Standards, desiring information on the intensity and duration of fires in various types of buildings, constructed the small building shown in Fig. 16 (about thirty feet by seventeen feet in outside dimensions) in its grounds at Washington, D. C. The walls are of all-rolok construction in Flemish bond, 8″ thick. To date four fire tests have been conducted in this building; and with the exception of the soot around the window openings the brickwork does not appear to an observer to be any the worse for the intense fires that have burned themselves out in its interior.

8. When constructing the building the Bureau desired also to give Ideal construction a practical test to see if difficulties would be encountered in forming window and door openings, pilasters and corner details. "Apparently little trouble was encountered in these respects," according to a statement made by the U. S. Bureau of Standards. The statement continues: "Sometimes the inner stretchers did not line up with the outside stretchers and the header did not go through the wall, a bat being placed on the outside where the full header would normally be placed. At some points we had as many as three stretchers without a header. Apparently this did not seriously decrease the stability of the inner face, these stretchers being tied with full courses above and below. All of the fire tests were made with an inside plastered surface. A considerable portion of the plaster fell off during the first part of the fire, leaving as much as one-third or one-fourth of the interior brick surface exposed."

9. At the time this report was made three tests had been run in this building. Another test was made subsequently.

10. "We have now made three tests in the building, which shows no instability of the walls," continues the statement, "although cracks formed adjacent to the floor and window openings during the test up to three-sixteenths inch wide, which, on cooling, closed up to less than one-eighth inch. The average intensity and duration of each fire did not exceed that incident with the first hour, using the standard time temperature curve for fire tests. We contemplate making several further tests in the building with occupancies giving more severe fires than those introduced up to the present."

U. S. Bureau of Standards Physicist on Strength of Ideal Walls:

11. Dr. A. H. Stang, Physicist, U. S. Bureau of Standards, commenting upon tests made by the Bureau on the Ideal wall, at a recent convention of the Common Brick Manufacturers' Association reported that the results of tests were as follows:—

Strength:

a. All-rolok walls in Flemish bond and solid brick walls eight inches thick have about equal strength under concentric loading; each type of wall being laid either in lime, cement-lime, or cement mortar.

b. When the load is applied with an eccentricity of two inches, the eight inch all-rolok walls in Flemish bond were 24 per cent. stronger than eight inch solid walls when cement-lime mortar was used for both types.

c. Under concentric loading, eight inch walls laid in cement mortar were 24 per cent. stronger than similar walls laid in cement-lime mortar, and 84 per cent. stronger than similar walls laid in lime mortar.

d. One side thrust test was made on one specimen each of the all-rolok wall in Flemish bond and the solid brick wall, both eight inches thick. (The panels were six feet wide and nine feet high). Two large timbers were placed against the side of the wall and jacked against the testing machine. The 8-inch solid wall broke under 6,280 pounds side thrust and under exactly the same conditions the Ideal wall broke when there was a side thrust of 6,520 pounds, a trifle in favor of the Ideal. Since there was one specimen only, I think we can say that the walls were equally strong.

e. About 30 per cent. less material was used for all-rolok Flemish bond walls than for solid brick walls.

f. The time required to lay the test panels of Ideal wall was about the same as for laying the solid brick panels.

Bricklayer Production:

g. 1,100 brick per day was the average bricklayer production when laying all-rolok test walls in Flemish bond in lime mortar, the work being done by contract.

Ideal Walls—Where Allowed and Recommended:

12. The Ideal wall is permitted under the ordinances of many cities. It is impossible to give a complete list of such cities. It is only necessary to say, however, that the Model Building Code of the U. S. Department of Commerce recognizes the Ideal wall; and that such cities as Detroit, Mich.; Cleveland, Ohio; New Haven, Conn.; and other large centres permit the Ideal wall.

13. At a recent meeting of the Building Officials' Conference the following resolution was passed:—

> "Resolved: That the Building Officials Conference in meeting assembled at Louisville, Kentucky, having previously declared that hollow walls of brick, more particularly the type of construction known as the 'Ideal wall' can be safely constructed, believe that such type of brick wall construction should be permitted by building codes within the limitations and under the conditions specified in the report of the Building Code Committee of the U. S. Department of Commerce, entitled, 'Recommended Minimum Requirements for Small Dwelling Construction'."

Suggested Paragraphs for Amendment of Building Codes to Allow Ideal Wall Construction:

14. *a.* Hollow walls constructed with standard solid well burned brick (known as Ideal or hollow walls of brick) as hereafter described may be built wherever walls or piers or back-up construction of hollow tile, concrete block, or other hollow building units are permitted under this ordinance.

b. The provisions of this ordinance governing the minimum thickness and maximum heights of hollow tile, concrete block, or other hollow building unit walls shall apply to Ideal walls.

c. The maximum unit loads which may be placed upon Ideal wall construction shall be the same as the

maximum unit loads which under this ordinance may be placed upon hollow tile or concrete block or other walls of hollow building units.

d. The minimum unit strength requirement for brick for use in Ideal wall construction shall be the same as defined by this ordinance for the minimum unit strength of hollow tile, concrete blocks or other building units; provided that when the minimum unit compressive strength of hollow units is based on their gross area, the minimum compressive strength of brick for Ideal wall construction shall be determined as follows: Take the lowest permitted compressive strength in gross area of any type of hollow unit allowed under this ordinance. Increase this figure by 44%*. The result shall be the minimum compressive strength for brick for use in Ideal wall construction.

Figure 16. Four intense fires have not harmed this 8-inch Ideal wall test structure at the U. S. Bureau of Standards.

e. Ideal or hollow walls of brick may be laid with some or all of the brick on edge, and such walls shall have at least the following number of continuous vertical thicknesses or withes running in the direction of the wall, and each withe shall have a thickness of at least two and one-quarter inches of solid material, namely:—eight inch walls, two withes; twelve inch walls, three withes; sixteen inch walls, four withes.

f. There shall not be more than four courses of brick when laid on edge, or more than six courses of brick when laid flat, between header courses; provided that in walls eight inches thick in which each of the two withes is of brick on edge, there shall be not more than three courses of brick on edge between header courses.

g. Header courses in 8″ walls shall consist entirely of headers laid flat or on edge, or may consist of Flemish bond headers.

h. For walls 12 inches in thickness the minimum requirement for the headers in each header course shall be as follows: Two headers shall be placed adjoining each other to tie the facing to the backing. Alongside of and adjoining these headers shall be similarly placed two more headers with faces set in 4″ from the face of the wall to tie the two withes of the backing together. These pairs of headers shall alternate continuously for the full length of the wall.

i. For walls 16″ in thickness the minimum requirement for the headers in each header course shall be as follows: The three withes in the outside 12″ thickness shall be tied together with the minimum number of headers defined in the preceding paragraph (*h*) and the additional withe shall be tied to such 12″ thickness with headers laid in pairs and with a distance of not more than one stretcher between each pair. This arrangement shall be continued for the full length of the wall.

*44% is the percentage of non-bearing area to gross area in Ideal wall construction.

THE ECONOMY WALL

General Description:

1. The Economy wall is a type of brick construction designed primarily for one and two story and attic houses, for garages, filling stations and many other minor buildings.

2. It is placed on top of the foundation wall, which is built in the ordinary way.

3. The Economy wall is a brick wall four inches thick, blanketed with back mortaring, strengthened at intervals with vertical pilasters, having brick corbelling for the support of floors and roof, providing a 4″ outside reveal for doors and windows, and with every window and door frame bricked in.

4. This wall makes a scientific and highly efficient use of the minimum amount of material that can properly be used in wall construction. The cost is therefore kept down to the minimum. That this wall is the lowest cost masonry wall is only natural, for brick is the cheapest manufactured material on the market.

5. In the Economy wall, the brickwork supports all the loads and resists all the stresses in the wall. The Economy wall is thus a true masonry wall, and is not to be confused with brick veneer construction, in which an outside shell of brickwork is tied to a framework which supports all the load.

6. A building constructed with the Economy wall has the qualities that have long been associated with brick construction—permanence, low upkeep cost, coolness in summer and warmth in winter, and great fire resistiveness.

7. The Economy wall has exactly the same pleasing outside appearance as ordinary solid brickwork.

8. The mortar blanket on the inside face of the 4″ wall is placed as the wall goes up by the same mechanic who builds it, thus avoiding extra overhead expense.

9. Inside plastering is on light vertical furring strips, supported by the wall.

10. This wall has a large factor of safety, is warm and is fire safe.

11. It requires from 7⅓ to 7½ brick per square foot in a straight run of wall. (See pars. 44 to 46, page 45.)

Thoroughly Tested by Experience:

12. When the Economy wall was first promoted—in February 1924—it was thought to be entirely new, and was so announced. It has since been found, however, that the principles of its use are not new, and that Economy wall houses have been giving satisfactory service for at least forty-five years on this continent, and in all probability other instances of this construction could be found in the older countries of the world.

More Than Ample Strength:

13. It is common knowledge that the 4″ brick wall—even without pilasters—is amply strong to carry the weight of several stories of a building of residential occupancy. That fact has been thoroughly established both by laboratory test and by the far more convincing testimony of the use of 4″ walls for such purposes in large numbers of buildings in successful use in many places for many years. It is standard practice to use 4″ brick walls as bearing partitions in the best class of residential construction in England and on the Continent, and Fig. 1 illustrates a typical 4″ wall in an English house under construction. Note that there are joists resting on each side of this wall. The permanence and the first class construction of English houses is proverbial.

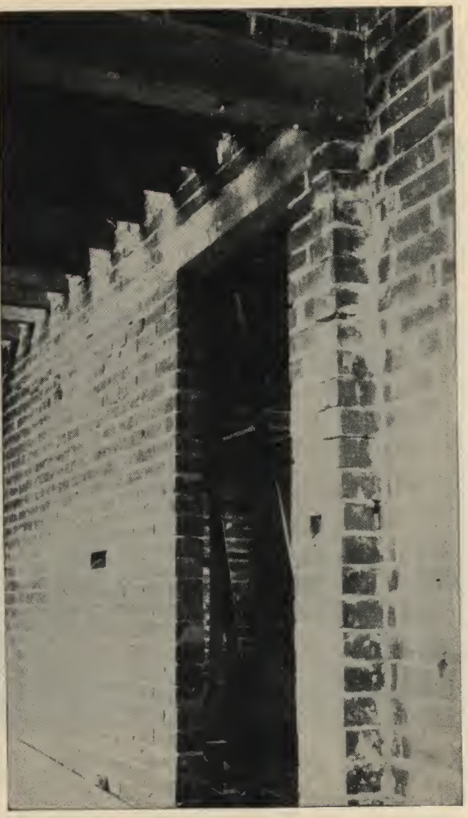


Fig. 1. Construction of typical English house with 4" bearing wall

14. Fig. 2 shows a brick interior bearing wall in a building which stood for upwards of eighty years in Trenton, N. J., and which was being demolished to make room for a large structure when this picture was taken. This 4″ wall was constructed of low grade brick, called "salmon" brick. It should be noted, however, that even salmon brick has a strength in excess of one thousand pounds per square inch when *tested on edge*.

15. The U. S. Bureau of Standards recently made some strength tests on 4″ brick walls in connection with a series of fire tests, and found that the crushing strength of specimens from 15 to 27 ins. in length and from 22 to 40 ins. in height averaged 1,876 pounds *per square inch*. Twelve specimens and three kinds of brick were used in obtaining this average. When it is remembered that the brickwork at the first floor line of a two story and attic house is never loaded in excess of 30 to 40 pounds per square inch it will be seen that there is a "factor of safety" of 53, according to the above figures, when using the plain 4″ wall for the outer walls of a two story and attic house. That is, the wall would not fail until the maximum load multiplied fifty-three times had in some fashion been placed upon it.

16. It must be remembered that the Economy wall is a 4″ wall *strengthened by pilasters*, and that the strength data given above refers to plain 4″ walls which are not thus strengthened. The Economy wall is thus obviously much stronger than the plain 4″ wall, with an even greater factor of safety.

Insulating Value:

17. The perfect house is cool in summer and warm in winter. The most effective insulation known is the dead air cell, which must be sealed and microscopical in size to be effective. Large air spaces are ineffective as insulators.

18. A brick is made by burning a piece of clay for days in a kiln at a practically white hot temperature. A multitude of minute combustible particles in the clay is burned out and the tiny space which each particle occupied is left vacant in the form of an equally tiny air cell. Every brick contains a multitude of

Fig. 2. Four-inch salmon brick bearing partition in old building, Trenton, N. J.

such air cells which are true dead air cells, and solid brick walls are thus the most efficient insulators, the degree of their efficiency depending upon the thickness of the solid material in the wall. "Coolest in summer and warmest in winter" is the long established characteristic of brickwork. This is borne out by the degree of the rapidity of heat transmission through various kinds of walls during fire tests, by the theoretical computations of heating and ventilating engineers, and last but not least, by the actual experience of those who have lived in Economy wall houses in cold climates. Naturally the 4″ brick wall has a lower degree of resistiveness than the 8″ solid brick wall, but it is a warmer wall in winter and a cooler wall in summer than other types of wall that are also used in residence construction, as the following table shows. The "unit of heat loss" means the measure of the heat passing through the walls, figured on an hourly basis.

Heat Conduction Properties of Various Walls

The lower the figure, the better the insulation afforded by the wall.

Thickness of wall	Type of Wall	Unit of Heat Loss
4 inch	Plain brick wall (not back mortared)	.57
4 inch	Hollow tile	.64
4 inch	Hollow tile plastered one side	.57
6 inch	Hollow tile	.57
4 inch	Concrete	.85
8 inch	Concrete	.60
Stucco on metal lath and frame construction, consisting of stucco on metal lath, studs, and plaster on metal lath		.64

19. It thus appears that the new wall, even without the back mortaring here recommended, affords better protection from heat and cold than an 8″ concrete wall or a 4″ hollow tile wall, and the same protection as afforded by a 4″ thickness of hollow tile plastered on one side or by a 6″ thickness of hollow tile unplastered.

20. All the figures above, except those for the 4″ brick wall, are quoted from the 1924 yearbook of the American Society of Heating and Ventilating Engineers. The values for the 4″ brick wall have been very carefully computed by the formula given on page 1089, vol. 2, of Hool and Johnson's Handbook of Building Construction. The results given by this formula check (within a few decimal points) the figures quoted from the yearbook. These figures can be therefore confidently relied upon as being conservative and safe.

21. This conclusion is amply verified by the experience of those who have lived in Economy wall houses in Canada for many years. Letters from the occupants of three such houses are printed on page 47.

Fire Resistiveness:

22. Most remarkable results have been secured recently by the U. S. Bureau of Standards in fire tests of 4″ brick walls. These test results are the more noteworthy when it is considered that they were made upon walls about ten and a half feet high, a great deal higher than the distance from floor to floor in any residence, that the walls tested were plain 4″ walls without the pilasters which are an essential feature of the Economy wall, and that the walls were not back-mortared.

23. This Association asked the Bureau of Standards for a preliminary statement on these tests. This the officials of the Bureau kindly consented to give, and the official statement follows. This must be read with the fact in mind that every pronouncement of the Bureau is extremely conservative and that this statement was made before all the data derived from the tests had been studied and analyzed; and that nobody can at present say to what degree the pilasters and the back mortaring will increase the high degree of the stability and fire resistiveness of plain 4″ walls. It is obvious, however, that even a plain 4″ brick wall without such pilasters has a very high factor of safety for use in residence construction. The following is the official statement of the U. S. Bureau of Standards:

24. "The U. S. Bureau of Standards has recently completed a series of fire tests of brick walls and

Fig. 3. General view of inside of the wall

auxiliary load tests of brick masonry. In the fire tests the plain 4″ walls gave heat resistance equal to that required for the one-hour classification.* A later series of fire tests under load with walls 10½ feet high indicated ability to sustain central working loads under fire exposure for periods equal to or exceeding that required for the one-hour classification.

25. "The load tests of auxiliary masonry specimens indicated greater unit strengths by about one-third for the 4″ walls than for 8″ and 12″ walls, the total load sustained per lineal foot of wall being about two-thirds of that sustained by the 8″ walls.** It is expected that the introduction of pilasters will stiffen the wall and help to make it a reliable member as it concerns stability both under load and fire conditions."

* American Architect, Sept. 26 and Oct. 10, 1923.
** Proc. Am. Soc. for Testing Materials, 1924.

CONSTRUCTION

Construction Is Simple:

1. The construction of this wall is easy and simple. The bricklayer has little new to learn, and if he can lay a solid wall in common bond—the easiest bond of all to lay—he can construct the Economy wall without difficulty.

2. The following detailed instructions should not lead anyone to imagine that the wall is complicated. A detailed description of any innovation must of necessity be thorough, although much of the information herein given concerns facts and practices that are so familiar to the average builder and mason that their performance is second nature to each.

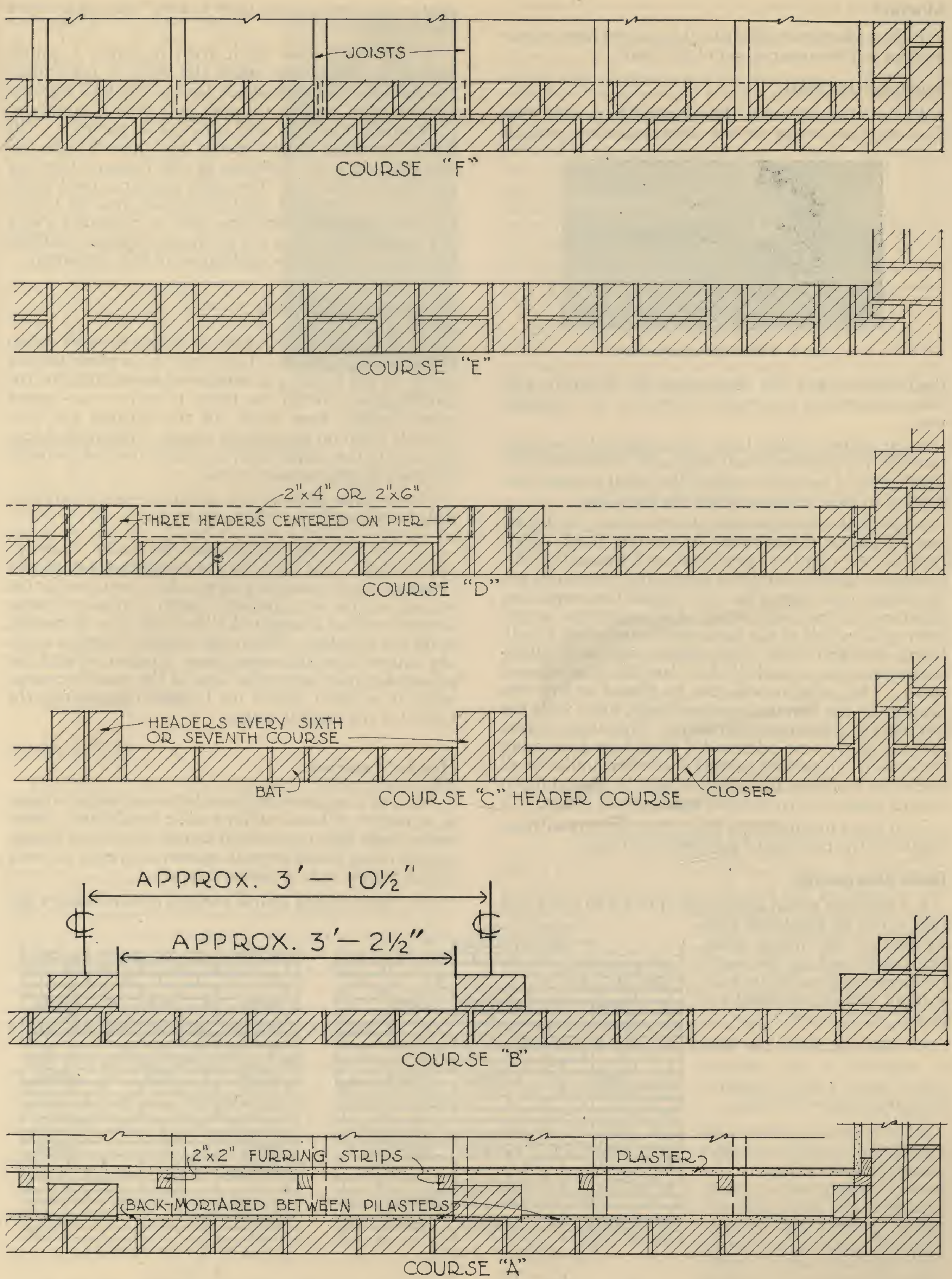


Fig. 4. Plan showing construction by courses. For key to lettering on courses see Fig. 8, page 42

Mortar:

3. It is recommended that 1:1:6 cement lime mortar be used in the construction of this wall.

Starting the Wall:

4. In houses with basements beneath, the Economy wall starts on top of the basement wall at

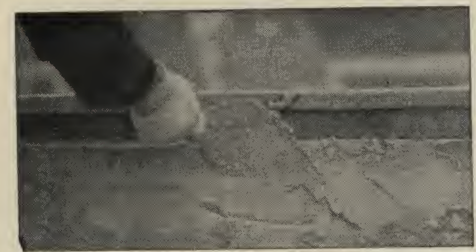


Fig. 5. Back-mortaring the wall

the bottom of the first floor joists, the basement wall being constructed preferably of brick in the ordinary way.

5. In houses which have no excavated basement beneath, the Economy wall may start at the footings, which should be carried down the usual distance according to local practice below the frost line.

6. Start the construction at any corner by laying one 4″ course of brickwork in running bond. Then back up the corner as per detail and locate the first pilaster so that there is left a panel of 4″ brickwork 4¼ stretchers wide (see Fig. 4). Space the remaining pilasters to the next corner 4½ stretchers apart, letting the width of the last panel come what it will. Using standard brick, the pilasters will be 3′ 10½″ centre to centre, or with 3′ 2½″ clear distance between them. The pilasters will thus be placed so that the headers in the bonding courses break joint with the stretcher courses above and below. That is the reason for placing the first pilaster 4¼ stretchers away from the corner. In private garages and other similar small one story buildings the pilasters may be spaced much further apart—up to seven or eight feet on centre.

7. It saves much time to locate the pilasters without regard to the position of windows and doors.

Back Mortaring:

8. One great added advantage of this wall is the fact that it can be blanketed with mortar on the inside while being built and by the same mechanic who builds the wall, without added overhead expense.

9. This feature of the wall is required in all sections which have winter temperatures much below freezing.

10. Constructing the wall with a mortar blanket behind also makes the laying of the brick a much more speedy process, for in laying the outside 4″ of brickwork the mason will make much better time if he is allowed to simply butter the front edge of the brick, leaving unfilled some portion of the vertical joint toward the inside of the building.

As the wall goes up it then becomes a simple matter for the mason, using the back of his trowel, to roughly mortar the inside face of the wall between the pilasters, sealing the wall and adding greatly to its warmth in winter and coolness in summer. The back mortaring is very easily and quickly done, requiring only a few minutes of the mason's time for covering a large area. The same mortar is used as for the joints in the wall itself, so that no mortar has to be mixed specially; and the wall is mortared every few courses as it goes up, so that no special scaffolding is required for the application of this insulation.

"Hacking" the Brick:

11. The speediest way for a mason to work when building any kind of a brick wall is to place temporarily on the backing a number of loose brick for the outside face. When the latter is built to an appropriate height, loose brick for the backing are temporarily piled on the outside course. When the backing is up to the proper level it is again used as a storage for brick for the outside course.

12. In some parts of the country this operation is called "hacking" by the bricklayers.

13. The Economy wall permits the ready "hacking" of the brick. The brick for the pilasters are naturally "hacked" on the outside course, while the brick for the outside course are "hacked" upon a piece of scrap lumber such as a length of 1″ x 4″ or 2″ x 4″ resting upon the pilasters. When the outside course is up to the proper level the wood piece is taken off and the pilasters carried up to the level of the outside course, when it is again placed for holding temporarily the brick for the outside course.

Header Courses:

14. The maximum distance between header courses is a matter of local building code regulation. Some codes state that every sixth course must be a header course, other codes permitting every seventh or every eighth course to be a header course.

15. The bonding course consists of two headers laid

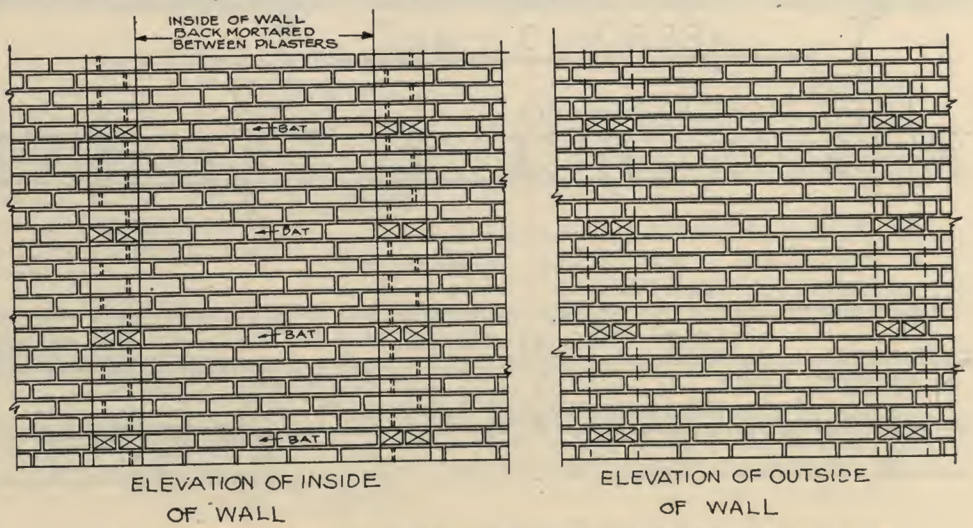


Fig. 6. Outside and inside elevation showing bonding. (Headers may be at every 6th or every 7th course according to local code.)

side by side upon each pilaster with a special detail at the corner. This is the only course in which it should be necessary to cut any brick and no more cutting is required than would be the case in any solid brick wall laid in common bond. Inasmuch as the spaces between the pilasters equal $4\frac{1}{2}$ stretchers, it is obvious that 4 stretchers and a bat must be placed between each pair of pilasters, except in the panels next to the corners in which 4 stretchers and a closer will be necessary (Fig. 4). The bat and the closer will look better if they are located in the center of the panels between the pilasters.

Fig. 7. Nailing anchor to 2"x2" strip

Locating the Window Openings:

16. When five or more courses (see paragraph 14) of brickwork with the pilasters have been laid in running bond we are ready for the header course. Before the latter is placed, however, the windows should be located. The doors will, of course, have been previously located when the level of the bottom of the sill was reached. It will be possible in many cases to slightly shift the position of these openings to make the jambs coincide with the location of one or both of the pilasters. Where this is impossible it will be necessary to build up special pilasters to form the jambs. These should now be started and carried up to the bonding course.

Window Sill:

17. Where brick sills are desired, (these being the most suitable for this and all other types of brick construction) place a 2″ x 2″ or 2″ x 4″ strip (depending on the span) to support the brick on edge forming the window sill, upon which latter the window frame is bedded and placed in the ordinary way. This strip is laid with its face flush with the brick pilasters and with a bearing of not over four inches at each end. On top of each end of the strip is nailed a metal anchor consisting of a short piece of hoop iron or a metal wall tie extending into the brickwork. (See Fig. 7).

Supports for Furring Strips on Pilasters:

18. The vertical strips supporting the lath for plastering are 2″ x 2″ strips where they occur between pilasters. (Fig. 8.) Where strips are needed in front of pilasters to keep the 16″ o. c. spacing, these are $\frac{7}{8}$″ x $1\frac{1}{2}$″. Provision should be made on the face of each pilaster for attaching these strips. This is best done by building an occasional horizontal plasterers lath into a joint of every pilaster; these laths occurring about every 2 feet vertically.

19. A plasterer's lath for the same purpose should also be built into the joint between the Flemish header course of the joist support and the stretcher course above. (See various detail sections.)

Construction Over Window and Door Heads:

20. The special pilasters (if any) which were built to form window and door jambs are not carried any higher than the heads of these openings (Fig. 3). The exterior 4″ thickness of brickwork over the openings may be supported either by an angle or by an arch. Where a pilaster occurs over an opening, this should preferably be supported on a steel lintel. Except for very small openings, the thrust of the ends of a relieving arch could not with safety be withstood by the pilasters even if headers should be placed at the intersection. A 2″ x 2″ horizontal nailing strip should be provided at the window head for the support of the furring strips. This nailing strip should be anchored into the brickwork in the same way as the strip below the sill.

21. Where no pilaster occurs above the opening, the inside steel angle is not needed, but the 2″ x 2″ is needed to support the furring strips and for nailing the trim. Fig. 9 shows details for window and door frames.

Metal Strip Over Window and Door Frames:

22. To eliminate all danger of moisture condensing on the inside of the 4″ wall and finding its way into the building, a piece of metal (galvanized metal is preferable), about $2\frac{1}{2}$″ wide and the length of the window or door frame is used as shown in Fig. 9. The edge of the metal is placed between the vertical portion of the exterior steel angle lintel and the brickwork (or between the outside of the frame and the arch if the outside 4″ of brickwork is supported by an arch). The portion projecting on the inside of the wall is bent into a horizontal position until the back mortaring is completed, after which it is bent up again with the top about $\frac{1}{2}$″ away from the pilaster. In this position the metal strip will drain any condensation to the outside of the building.

Corbelled Floor Support:

23. This wall is adapted for ordinary two story and attic houses. It is desirable always in a two story house to carry the corbelled floor support detail here described around on all sides of the building at the second floor line. It should also be used across gable walls, either in one or two story buildings. In addition, the floor corbelling renders a two story house much more fire resistive and stiffens the whole structure. The corbelled floor support is not required for bungalows and is not required to support the ceiling joists and rafters at the roof line. The corbelled floor support is shown in Figs. 10 to 14 and is constructed as follows:

24. At a distance of 4 courses below the bottom of the joists, corbel out the tops of the pilasters as detailed by using three full headers placed together. Upon these headers place lengths of 2″ x 4″ laid flat as shown. These lengths of 2″ x 4″ are placed with their outside face projecting about $\frac{7}{8}$″ beyond the face of the pilasters. The face of the 2″ x 4″ flat pieces will then be flush with the face of the vertical furring strips. These wood pieces should have a 4″ bearing at each end of the pilasters, leaving 4″ of brickwork between the ends of the pieces. The wood pieces are supported by brick "shims" to make their tops come

level with the top of the brick in the course. Upon this wood member is laid a "Flemish header course" 8″ thick as shown. (Fig. 4.) This course forms the corbel which supports the load of the floor above. On top of the Flemish header course is placed a stretcher course, also 8″ thick, and the joists are placed on the stretcher course. The lengths of 2″x4″ are laid in the wall primarily to give the floor construction the necessary stiffness during the course of erection, and to provide nailing for the vertical furring pieces.

25. When the wall has been built a few courses above the second floor level the wood member is not necessary for the support of the floor. Two factors come into operation here. The first is the supporting action of the Flemish header course, which in itself would be sufficient to hold up the floor above. The second is the natural arching action of seasoned brickwork, which assists in transferring some of the floor load to the pilasters.

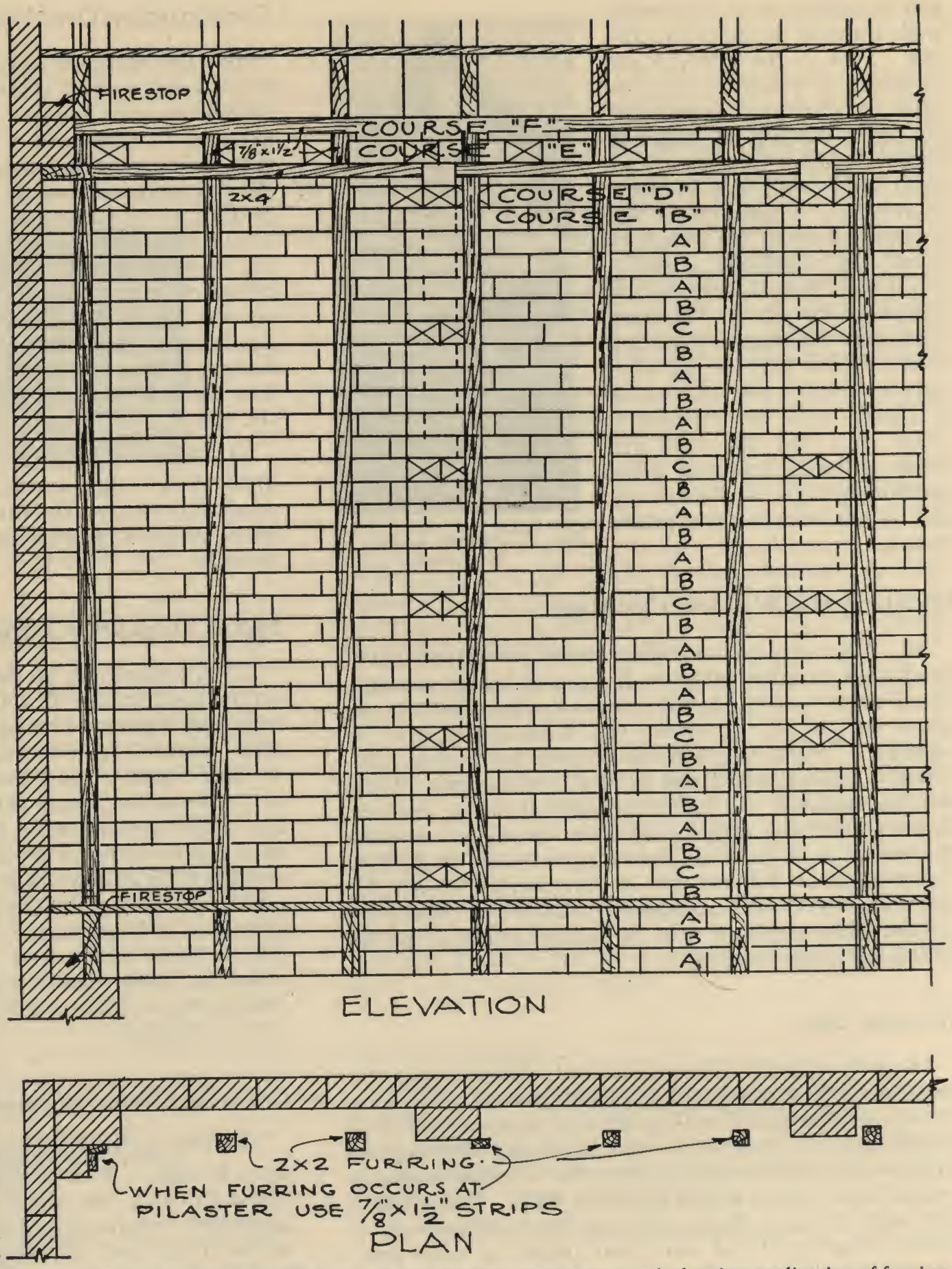


Fig. 8. Typical interior elevation of wall with back-mortaring omitted, showing application of furring strips. For plan of lettered courses see Fig. 4

Detail at Ceiling of One Story Bungalows and Second Floor of Two Story Houses:

26. The corbelled floor support feature described in paragraphs 24 and 25 is not necessary at the ceiling line of the second floor of a two story house (except at a gable) or at the ceiling line of one story bungalows or other buildings. In these cases a continuous piece of 2″ x 8″ (a piece of 2″ x 4″ would not be desirable here) is placed immediately below and directly supporting the ceiling joists. (See detail at roof line. Figs. 10 and 11.)

Floor Joists:

27. The laying of the floor joists is a very simple operation. They are simply spaced 16″ or any other desired dimension on center without reference to the location of the pilasters. (Fig. 12.)

28. It is obvious that fire cutting the joists is not necessary with this construction. In fact it should not be done as there is much advantage in running the rough floor to the wall.

29. In case a joist should come in the center of one of the pilasters, a 4″ course of bats may be built on each side of the joists, and the regular pilaster started upon this support above the level of the top of the joist. (Fig. 12.) A pilaster can be shifted slightly to one side to a distance of one or two inches for the height of the floor joists where necessary for the proper spacing of the latter. Above the level of the joists the pilaster can be shifted back to its normal position.

Support of Joists Carrying Excessive Loads:

30. Where a joist bearing an excessive load (such as when the joists are doubled or trebled to take care of a framed opening in the floor) does not come nearly over a pilaster, a header formed of a joist with a 4″ bearing at each end over pilasters can be used as shown in Fig. 13 to transfer the load to the pilasters.

Anchors:

31. Where it is the local custom to use a positive tie between the floor or roof timbers and the masonry walls of any kind of construction, or where such ties or anchors are called for by the building codes, the ordinary types of anchors may be used very readily and easily in the Economy wall. While the practice of using such anchors is honored more in the breach than in the observance, this Association recommends the thorough anchoring of joists to walls. Anchors cost little, and in the event of a natural calamity such as a tornado or earthquake, buildings that are well anchored will come through without serious structural damage.

32. Wherever a pilaster occurs there is at that point a thickness of eight inches of masonry which can be anchored into.

33. If it is desired to anchor the ends of the joists at a point where their location does not coincide with the position of a pilaster, spike a piece of 2″ x 4″ between two of the joists outside the face of the pilaster and anchor to the 2″ x 4″. (See Fig. 12.)

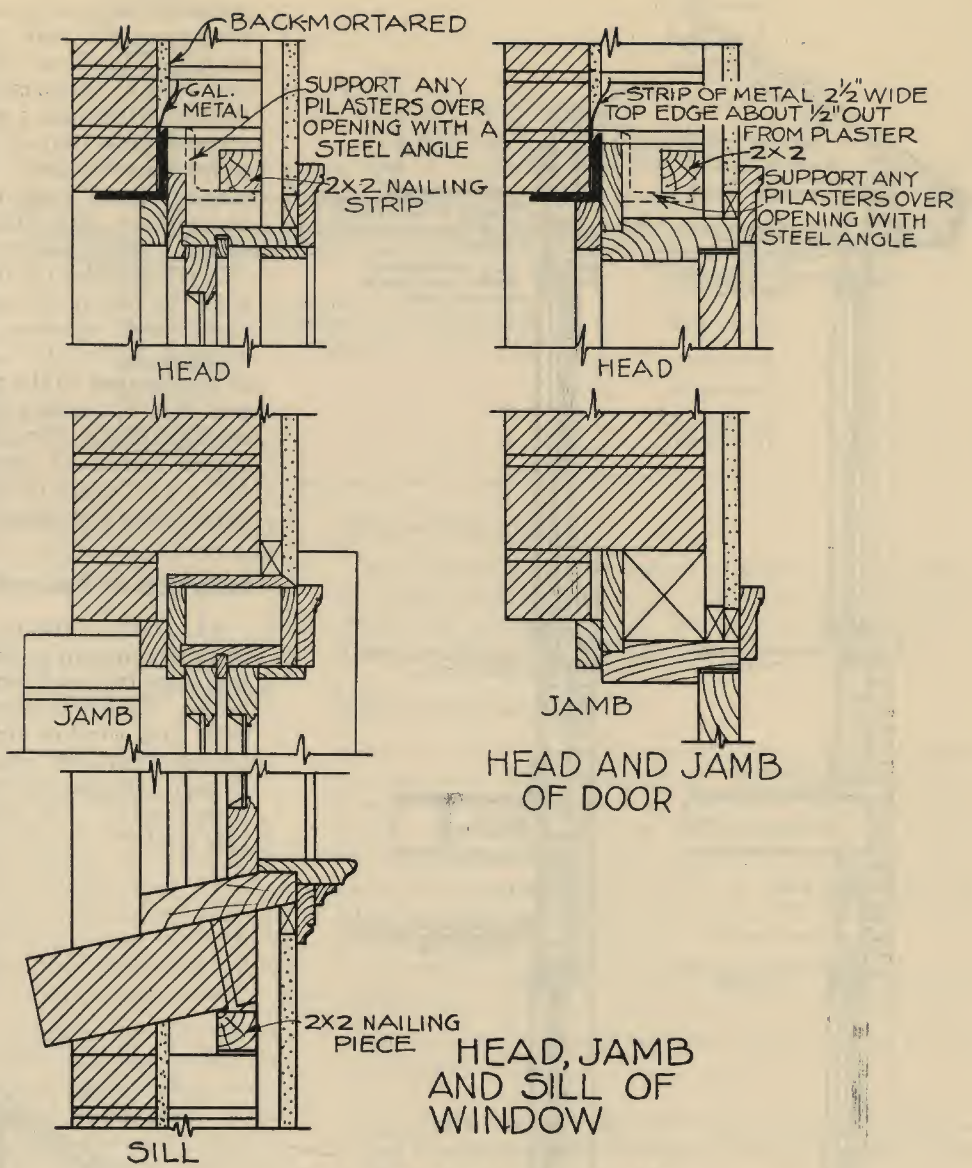


Fig. 9. Window and door frame details

Fire and Draft Stopping:

34. In line with other organizations, the Common Brick Manufacturers' Association has been devoting a great deal of study to this detail in connection with all types of walls. The object of fire and draft stopping is to prevent the upward movement of air from one story to another (and flame, if a fire has started) from the vertical spaces between furring strips, from the spaces between the joists, (in other words between the plaster ceiling and the wood floor above), and from the inside of the house to the exterior between the rafters at the point where they intersect the wall. Not only does fire and draft stopping tend to confine a possible fire to the room of its origin, but it makes a house easier to heat by retarding the flowing away of the warmed air.

35. In common with other types of brick construction the Economy wall lends itself admirably to this modern detail of residence construction.

36. For firestopping the floor where the ends of the joists rest upon the wall (second floor joists and second floor ceiling joists adjacent to a gable), place a piece of furring horizontally below the joists, to which it is to be nailed. This cuts off the vertical spaces between furring strips. Above the joist line, the rough floor may be run almost to the inside line of the 4″ brick wall, and on this flooring a single course of brick may be placed between the pilasters, well slushed to thoroughly fill the space between the masonry and the plaster. This cuts off the spaces between the joists and the plaster line. (Fig. 11.)

37. For firestopping the floor where the joists run parallel to the wall (where the first joist is naturally placed close to the brickwork), it is necessary only to run one additional course of brick to fill the space between joist and wall. The joist itself forms sufficient firestopping for the space within the floor.

38. For firestopping at the roof line, simply run the exterior 4″ thickness of brickwork up to the underside of the roof boards. (Fig. 11.)

Locating Pilasters at the Second Story:

39. The pilasters at the second story are simply run up vertically over those at the floor below. Naturally, there will be some variation in location and spacing of the windows, and these will require in most cases special pilasters to form the jambs.

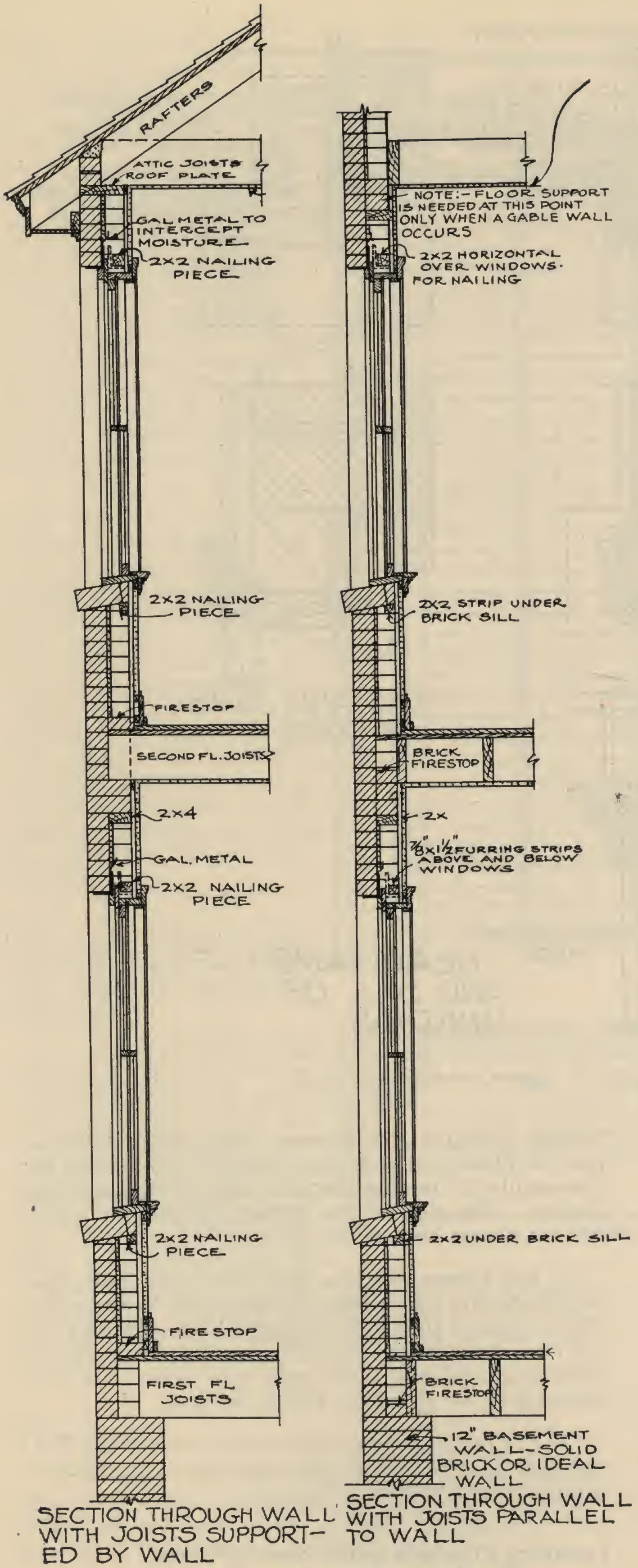


Fig. 10. Typical sections through the wall

Furring:

40. The furring strips for the support of the plastering laths are placed vertically 16″ o. c. Between pilasters these strips consist of pieces of 2″ x 2″ which span from the floor to the under side of the 2″ x 4″ pieces. The faces of the 2″ x 2″ vertical strips and the 2″ x 4″ horizontal pieces are flush. (Fig. 8.) Where strips must come in front of pilasters the strips are naturally thinner and the ordinary size ⅞″ x 1½″ strips may be used. ⅞″ x 1½″ strips are also employed above window and door openings and below the window sills. The bottom of the furring strips is secured either to the rough flooring or to a piece of 1″ x 4″ laid flat on the joists with its front edge flush with the face of the strips. (Figs. 11 and 14.) Above the 2″ x 4″ member of the detail forming the floor support, ⅞″ x 1½″ vertical strips are also used nailed at the bottom to the top of the 2″ x 4″, and at a point part way up, nailed also to the lath placed in the joint on top of the Flemish header course (Fig. 11.) As stated before, to form a fire stop at this point a ⅞″ x 1½″ piece of furring should be run horizontally close under the joists, to which it must be nailed.

Relation of Face of Plaster to Wall:

41. In the construction of any masonry wall it is the common custom to locate the inside face of the window and door frames flush with the plaster finish inside the house. This makes easy the application of trim. Stock door and window frames are so detailed that, when placed with a 4″ outside brick reveal, they have the proper relation to the inside plaster face of an 8″ furred wall. The same result is accomplished with this wall.

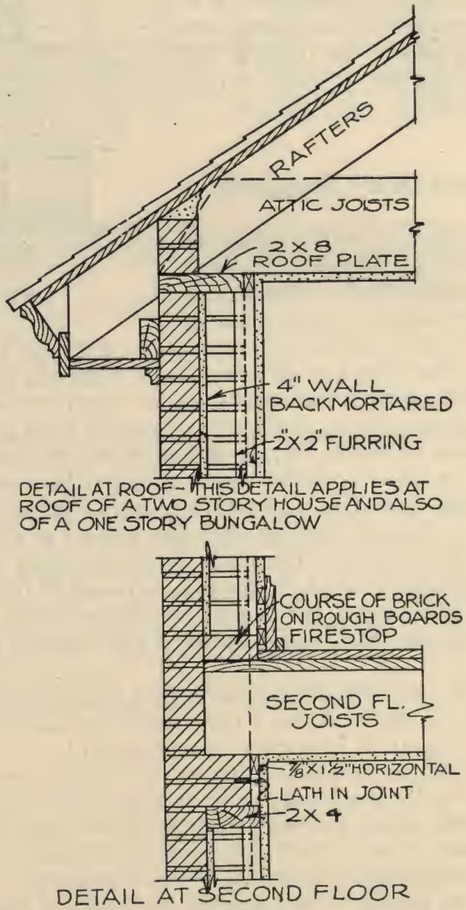


Fig. 11. Section at second floor line and roof line, with joists at right angles to wall

42. When a piece of 2″ x 6″ is used as the wood member of the corbelled floor support (pieces of 2″ x 4″ are shown on all the details) the projection of its edge naturally controls the location of the face of the furring strips and of the finished plaster. The nominal width—6″—of this piece is in reality only 5½″. This allows a projection of about 1¼″ beyond the inside line of the brick pilasters, bringing the plaster face to the desired point. As usual, some wedging is necessary behind the ⅞″ x 1½″ strips when these are placed on the brick pilasters.

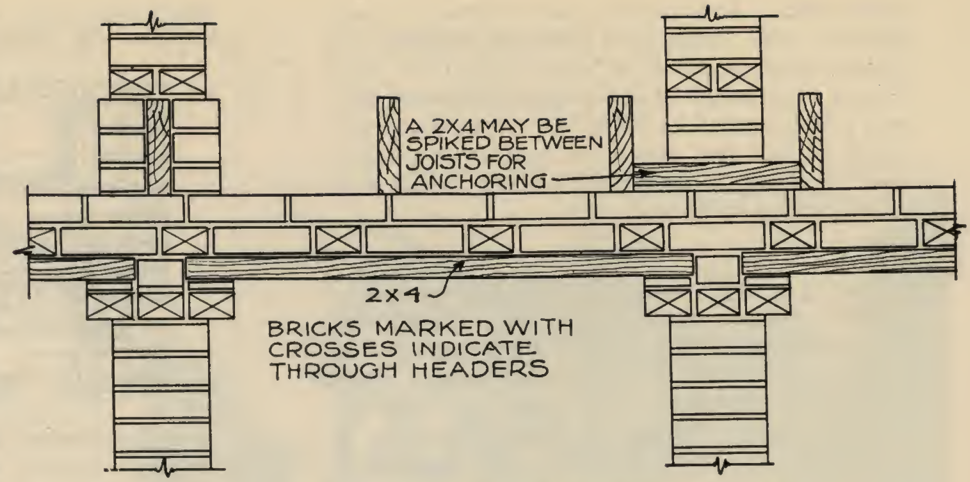


Fig. 12. Joists are spaced irrespective of location of pilasters

43. When a piece of 2″ x 4″ is used as the wood member of the floor support, its front edge is set out to the proper distance beyond the face of the pilaster.

Number of Brick Required:

44. The average number of brick required for the Economy wall is as follows:

For a one story bungalow—7.3 brick per square foot.

For a two story house—7.6 brick per square foot.

45. This slight difference is due to the fact that a one story bungalow does not require the corbelled floor support at the ceiling line of the first floor, a wood plate being sufficient to carry the rafters and ceiling joists. If, however, the bungalow is of the "story and a half type," with a second floor, the walls which run up two stories will require 7.6 brick per square foot.

46. Inasmuch as these average figures are subject to some variation on account of the fact that pilasters may be spaced more widely apart or more closely, that floor corbelling may or may not be required, and that special pilasters may be built to take care of special conditions, the quantities for the various elements of the wall are here given separately:

Plain 4″ wall without pilasters—6.16 brick per sq. ft.

Pilaster 8″ wide, 4″ thick—4.3 brick per foot run of pilaster.

Corner pilaster—6.4 brick per foot run of pilaster.

Floor corbelling—3.12 brick per foot run of corbelling.

Window sills—2.18 brick per foot run.

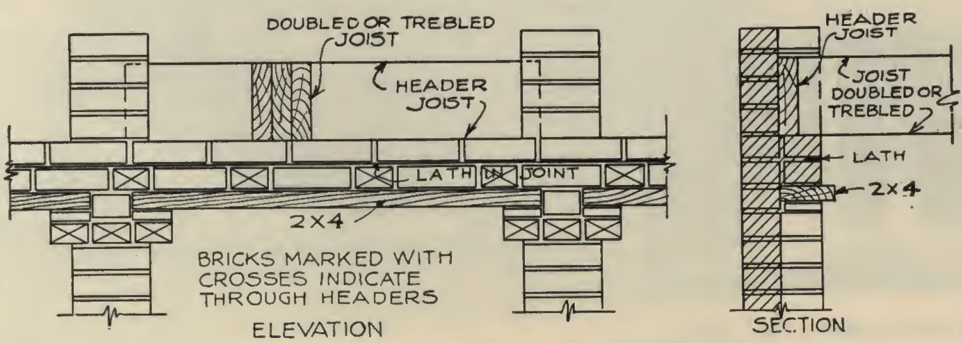


Fig. 13. Special framing for joists carrying concentrated loads

Mortar Required:

47. The amount of mortar required for this wall, including corners, pilasters, floor corbelling and back mortaring one half inch thick between pilasters, averages .091 cubic feet per square foot of wall.

Labor Required:

48. In walls with the average number of openings and corners, the contractor can safely and conservatively estimate that in front and other walls carefully faced, each mason will lay 650 exposed brick backed up with pilasters and floor corbelling and back mortared between pilasters per day in this wall; and for rougher work in side and rear walls 1000 exposed brick per day backed up as above.

49. This equals 105.5 sq. ft. per day for carefully faced work, and 162.3 sq. ft. per day for rougher work.

50. Laborer's time should be figured at ⅔ of the bricklayer's time.

Suggested Paragraphs for Amendment of Building Codes to Allow Economy Wall Construction

51. (a) Pilastered wall construction, consisting of a 4″ wall of standard solid well-burned brick with pilasters at intervals and with various other details as hereinafter required, and known as the Economy wall, may be built to form the exterior bearing walls of buildings of residential occupancy, of private one story garages, or of buildings of any other classification having floor loads not in excess of those prescribed in this ordinance for residence construction. The Economy wall shall not exceed 30 feet in height. When gable construction is used an additional height of 5 feet is permitted to the peak of the gable. The Economy wall shall not be used for exterior walls below grade.

(b) The wall shall be not less than three and three-quarter inches or one brick thick and shall be strengthened with brick pilasters not less than eight inches wide and four

inches thick. Every sixth course of brick in each pilaster shall consist of through headers. A pilaster shall be placed at each corner or at each change of direction of the wall and between corners pilasters shall be placed at a maximum distance of four feet centre to centre. A pilaster shall be placed at each jamb of every window or door opening in the wall.

(c) Bearing for floor joists shall rest upon co belling consisting of one course of headers—either Flemish or continuous, upon which shall be placed at least one additional course of brickwork eight inches thick to support the bottom of the joists. A wood member may be introduced to serve as a temporary support for the header course during construction and afterward as a support for the furring strips. This corbelled construction

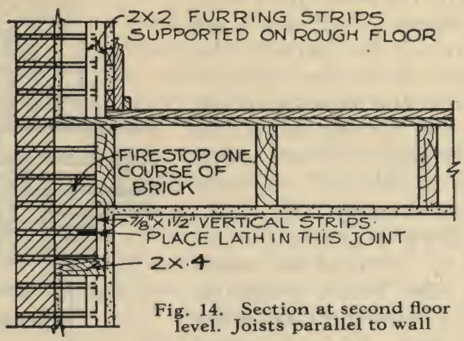
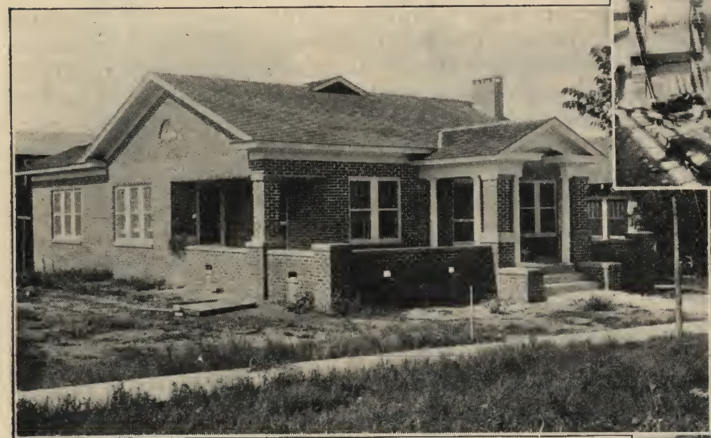


Fig. 14. Section at second floor level. Joists parallel to wall

shall be carried all around the building, both parallel to and at right angles with the floor joists.

Recently Built Economy Wall Houses

Interior View of House During Construction



Cost Only $300 More Than Frame

A 20 x 30 Oklahoma Store That Cost Complete, Only $850

850 Brick Per Day Were Laid by Each Bricklayer in This Ada, Oklahoma, Bungalow

The Above Ada Bungalow During Construction

ECONOMY WALL HOMES PROVE SATISFACTORY TO OWNERS

Mr. Charles R. Blair of Galt, Ontario, writes:

"The house which we live in has been in the control of our family for about thirty years. It is built with "pilastered wall construction," the outside walls being only four inches thick and strengthened every few feet with pilasters, nine inches wide. The wall is similar to the "Economy" wall. During all these years we have not spent a cent on upkeep for the brickwork, and today it looks as good as new. The house measures about twenty-five feet wide by forty-eight feet deep (25′ x 48′) and contains seven rooms.

"We have a hot water heating system and our average consumption of coal is about 7 tons for the winter season. One of the early occupants of the house was an old gentleman, who required the house to be more than ordinarily warm, and during those years we averaged about 9 tons to the season. We think that is remarkable, considering the size of our house. We sometimes get 25 degrees below zero weather here.

"Regardless of season we have always been very comfortable in our house both in winter and summer. We like our house and are well satisfied with it.

"Our house is one of a group of three, all built in the same way, and our neighbors find their houses as satisfactory as we do."

THE CHARLES R. BLAIR RESIDENCE AT GALT, ONT.

Mr. P. M. Foster of Galt, Ontario, writes:

"The house which I have owned and lived in for the last three years, and which is built with four-inch outside brick bearing walls, reinforced with pilasters, has been most satisfactory in every way.

"The house contains six rooms, each one of which is heated in the winter. During cold spells the thermometer sometimes drops to 20 degrees below zero, and even with this temperature outside, we are warm and comfortable inside the house. We only burned between five and six tons of coal during the whole of last winter. In summer the house is cool during the warm spells.

"Several of my friends and acquaintances live in houses built like mine, and I believe that without exception both they and I would use the same kind of construction if it was necessary to build again."

THE P. M. FOSTER RESIDENCE AT GALT, ONT.

Mr. W. R. Ackers of Brantford, Ontario, writes:

"I am sending you herewith a picture of my house which is constructed with 4 inch exterior brick walls, which are in many respects similar to the Economy wall which I understand is now being promoted by your Association. My house was built about 45 years ago and I have lived in it for over 20 years myself.

"We get very severe winter weather in this locality, the thermometer sometimes going down to 28 degrees below zero, and we have pretty warm summers. I am pleased to say that I have always found my house very comfortable. It has kept us comfortably warm in the coldest of weather at a very low cost for heating, and we are always cool, no matter how hot the weather is in summer. If I was going to build another house, I would certainly use the same construction."

BUILDING CODES SHOULD PERMIT EIGHT INCH WALLS FOR RESIDENCES

Brick Homes Benefit Communities:

1. It is greatly to the advantage of any community to have its homes constructed of brick. In the fire zones of cities only homes with fire safe walls are allowed. Brick reduces the danger of fire spreading from one house to another and so makes cities safer. Because of the permanent character of brick, a group of homes with brick walls does not get the run down appearance of a group of less permanent homes. It is impossible to say whether a brick house is five or fifty years old. Brick homes thus stabilize real estate values.

Many Large Cities Permit Eight Inch Walls:

2. That a thickness of 8″ for the brick walls of the usual home, above the basement, is ample, both for the first and second stories, is proved by recommendation of the Government, by endless examples in practice and by theory.

3. Some of the following data is taken from building codes and some from returns received direct from building officials. Thirty-five cities allow an eight inch wall for both stories of a two-story house. These are: Baltimore, Birmingham, Boston, Cambridge, Columbus, Cleveland, Detroit, Minneapolis, New York City, Philadelphia, Seattle, Spokane, Pittsburgh, Tacoma, Washington, D. C., Wilmington, Richmond, Syracuse, Tampa, Worcester, New Haven, Manchester, Rochester, Toledo, Duluth, Hartford, Rock Island, Lynn, Cincinnati, Trenton, Portland, Buffalo, Dayton, Camden, New Bedford and New Orleans. Many thousands of homes have been constructed in these cities with eight inch walls and many hundreds of thousands of people find them comfortable and satisfactory. No city which has adopted the eight inch wall has ever changed back to the twelve inch wall.

Weather Resistive and Strong:

4. Taking the other extreme, some cities require the first story wall of a dwelling house to be 16 inches thick, and many cities require a twelve inch wall at the first story and eight above. In the light of experience, a building code which insists on these things insists on a waste of material and money and encourages inferior construction.

5. An exterior wall must support the floors above and form an effective barrier against the elements. The fact that eight inch walls are allowed for the second story or for bungalow walls, indicates that such walls are considered in every city satisfactory for excluding the elements. The question of strength remains. Disregarding the experience of the cities mentioned, which would constitute a satisfactory reply in itself, see test results on the following pages on the actual strength of brickwork.

6. Experience and theory amply prove that the eight inch wall is weather resistive and possesses much more strength than the loads of a residence can ever develop.

7. For further proof, if proof be needed, that the eight inch wall is satisfactory above grade for two-story and attic residences, the following is a statement by D. Knickerbacker Boyd, Architect, who during the war acted as Chief of the Materials Information Section of the U. S. Housing Corporation:

8. "Of the thousands of houses built by the U. S. Housing Corporation and the Housing Division of the Emergency Fleet Corporation and the many thousands more for which drawings were made, the eight inch wall was the invariable rule. This thickness of wall was adopted after thorough investigation and most mature consideration and was even made to apply in several instances to localities where unfortunately at the time the minimum requirements were for thirteen inch walls. The Building authorities in these localities in most cases voluntarily conceded to the requirement of the Government that these houses should and could be built of this eight inch thickness—in spite of any prevailing provision to the contrary."

9. There is another important consideration; that the extra space taken up by the twelve inch thickness reduces the area of the rooms in the house. In the case of a house twenty by thirty feet, approximately thirty-one square feet of area is thus lost on each story, an area equal to a small bathroom or several good closets.

10. The eight inch brick wall is enormously strong; it is unquestionably fire-safe; it now forms warm and dry walls for the homes of multitudes of people and gives a man of small or average means free choice of his building material without taxing his preference for good construction. Building codes not already permitting this thickness of brick wall should be amended so that both inside and outside the fire zones the eight inch solid or Ideal wall will be allowed.

Government Advises Eight Inch Thickness:

11. The Building Code Committee of the U. S. Department of Commerce recommends that eight inch brick walls be allowed for the upper thirty feet of exterior walls of residences, with an additional allowance of five feet for gables. Foundation walls 12 inches thick are recommended for the excavated portions and 8 inches thick for unexcavated portions of the basement.

Thin Brick Partitions:

14. For interior bearing or non-bearing partitions in residences the 4″ brick wall is strong and much more fire resistive than partitions of wooden studs and their use is recommended for at least some of the partitions in residences. Such partitions have ample strength to carry floor joists at the first floor, second floor and attic levels. They must either extend up from the basement floor or be carried on steel joists at the basement ceiling level, supported on brick piers.

PROPERTIES OF BRICK AND BRICKWORK

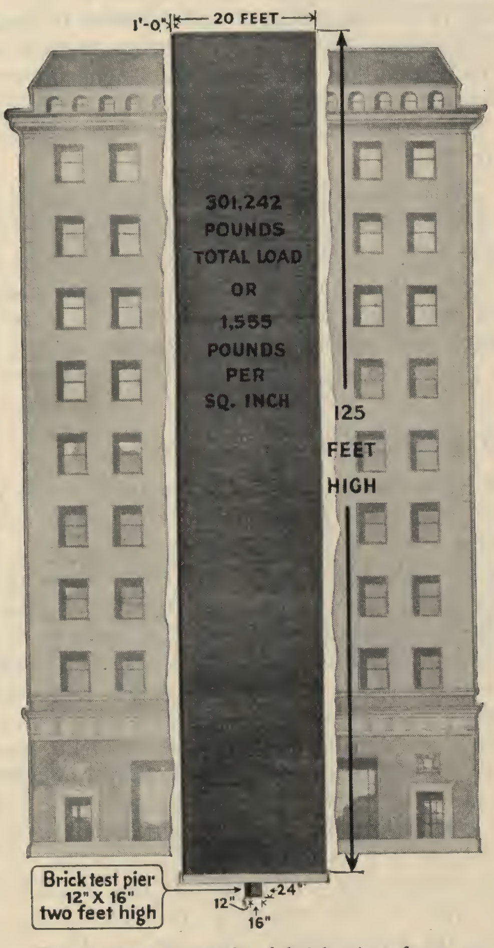
THE STRENGTH OF ORDINARY BRICKWORK

Noted Engineer Makes Strength Investigation:

In order to determine the ratio of the strength of brickwork as actually constructed to the strength of laboratory specimens especially constructed for tests, Mr. Rudolph P. Miller, member American Society of Civil Engineers, American Institute of Consulting Engineers and American Society for Testing Materials; formerly Superintendent of Buildings, Borough of Manhattan, New York City and President of the Building Officials' Conference, made the tests described here and wrote the report which follows.

Test Piers Cut from Old Wall:

In the course of demolition during August, 1919, of the four-story brick building constituting a wing of the former home of the Racquet and Tennis Club at 26 to 28 West 43rd Street, New York City, an effort was made to secure samples of the brickwork. On account of the difficulty in removing the masonry, suitable samples could not be taken from the side walls. The blasting which was necessary to demolish the masonry so shattered the brickwork that it could not be used for the purpose. An interior brick pier, however, built in an eight-inch partition wall in the sub-basement and which could be removed without blasting, was found and was used. The pier was twenty inches square in cross section and about ten feet high. For test purposes it was cut into four sections averaging about two feet in height, and trimmed down to approximately twelve inches by sixteen inches in cross section in order to keep within the capacity of the testing machine. Two sides of the specimens were the original finished faces of the pier.



The average strength of brick piers from an actual New York building was 1,555 lbs. per sq. in. The piers, 12″ x 16″ x 24″ supported an average load at failure represented by a 12″ solid brick wall twenty feet wide and one hundred and twenty-five feet high.

The prime object of the tests made by Mr. Miller was to find the strength of ordinary brickwork laid in the ordinary way as part of the regular day's work of the average modern bricklayer.

The results are here discussed and comparisons drawn with results of other tests upon specimens of brickwork built specially for testing.

Test specimens were obtained from a New York building being demolished—usual brickwork in every way, built of Hudson River common brick, laid in common bond, every sixth course a header course in 1:3 Portland cement mortar. The joints were not thoroughly slushed (although fairly well filled) and contained the occasional voids in which an ordinary lead pencil could be inserted, usually found in ordinary good acceptable brickwork. The brickwork had been under actual load for many years; also subjected to shock during demolition, by transportation to the laboratory, and by trimming for the testing machine.

Four specimens were trimmed to about 2 feet high and 12 x 16 inches. They supported at failure an average load of 1,555 pounds per square inch; graphically depicted here.

There was nothing unusual about the character of this brickwork. It was laid up in ordinary common bond, every sixth course a header, as called for by the New York building code. The workmanship was good, but apparently no especial care was taken to produce superior work. The joints were not thoroughly slushed up, as they were in the side walls of the building, and though the joints were fairly well filled it showed voids here and there in which an ordinary lead pencil could be inserted, such as are not unusual in ordinary, good, acceptable brickwork, representative of what was then and is now being done by contractors who exercise ordinary supervision over their work.

The brick used were from the Hudson River district. They were apparently all sound, whole, well-burned brick. Though it had the appearance of having some lime in it, the mortar used was, according to Mr. George V. Brown, superintendent for the contractor who erected the building, a straight cement mortar mixed in the proportion of one part of cement to three parts of sand. Portland cement was used.

Fig. A. Test Piers from Racquet and Tennis Club Building

The building, from which the brickwork was taken, was erected in 1903 by Marc Eidlitz & Son, builders, in accordance with the plans and specifications of Cyrus L. W. Eidlitz, architect.

The pier from which the brickwork was taken carried a comparatively light load consisting of a small area of floor construction with such live load as might come on a floor used as offices and reception rooms. The load on the pier probably did not at any time exceed twenty tons or 100 pounds per square inch; ordinarily the load was probably not more than one-fourth of that amount.

Results of Tests:

The ultimate crushing strengths of the specimens were determined at the Columbia University testing laboratory in a 400,000-pound Olsen Universal testing machine. Suitable bearing surfaces at the top and bottom of the specimens were secured by first facing with cement mortar to make a flat surface and after this had set sufficiently and when placing the specimens in the testing machine, smoothing out all irregularities with plaster of Paris, the initial load being put on before the plaster had hardened.

The results of the tests are shown in Table 1.

TABLE 1

Tests on Old Brickwork from Racquet and Tennis Club, New York City

By Rudolph P. Miller

Specimens	Height		Area in Compression Sq. in.	Ultimate Strength		First Crack at lb. per sq. in.
	Inches	Courses		Total lbs.	Per Sq. in. lbs.	
1	23½	9	193.60	268,970	*1,389	516
A	27⅛	10	206.25	181,000	877	640
B	24½	9	186.34	390,000	*2,093	1588
C	21⅝	8	196.00	365,000	*1,862	1275
*Aver	age ulti	mate st	rength of	specimens 1, B and C	1,781	lbs. sq.in.

The bearing plate on Pier A was uneven, and this is believed to be the cause of the lower recorded strength of this pier. The average ultimate strength including Pier A is 1555 pounds per sq. inch.

The test on specimen No. 1 was made September 4, 1920, as a preliminary trial to get some idea as to the strength that might be developed. No particular note was made of the position of headers, nor of the nature of the failure except that it manifested itself as it did in all the specimens, in vertical shear cracks. The first indication of any crack occurred when the load had reached 516 pounds per square inch.

The other specimens were tested September 9, 1920. The photographs show all four sides of the specimens from which the arrangement of the bond can be seen. It is further indicated in the diagrams. In these tests the first cracks appeared when the loads were approximately three-fourths of the ultimate.

Flexure of Brick Causes Failure:

In all cases the cracks first appeared in the brick and started at some point where there was a void in the mortar joint, showing that there was an uneven pressure on different parts of the brick, causing flexure in the brick with subsequent rupture. This was quite characteristic throughout the brickwork. It was noted, too, that the cracks which developed early in the process of disintegration, occurred in the headers which tied the brick of the outer exposed surfaces of the finished pier to the interior brickwork, again showing an unequal pressure on the two portions of the brick. The general development of the failure in these several specimens was along vertical cracks throughout the height of the specimen, separating the brick on the outside face from the rest of the masonry, indicating that the brickwork on the outside face carried the greater part of the load before it was transmitted into the backing.

The low result in the case of specimen "A" was probably due, in part at least, to uneven bearing

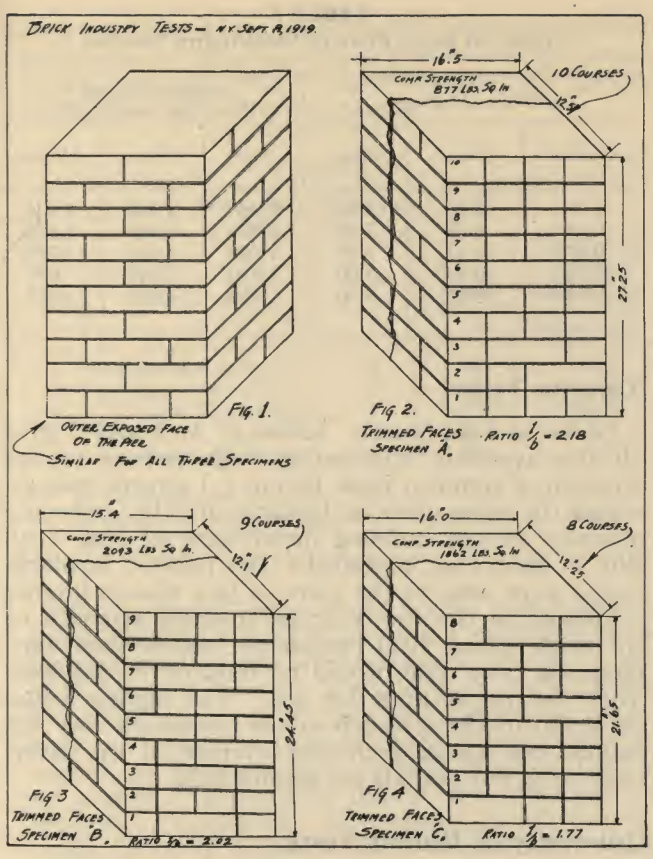


Fig. B. Diagram Indicating Bond of Test Specimens, also General Location of Cracks First Appearing

on the pressure plate of the testing machine. After the specimen had been placed and the initial load applied it was noticed the bearing at the top of the pier did not seem quite true. The test, however, was allowed to proceed without readjustment.

The higher value in specimen "B" over specimen "C" was probably due to the position of the bonding courses. In "B" there were headers in the second courses from top and bottom, whereas in "C" there was only one such header course and that about midway between top and bottom (fourth course from one end.)

The average crushing strength of the four test specimens can certainly be assumed to be a fair value of the brickwork; moreover, it is confidently believed that the average strength of specimens "1," "B," and "C" (1781 pounds per square inch) would be more truly representative.

Comparison with Other Tests:

A comparison of the results of these tests of brickwork as actually laid in a building with no thought that it might ever be tested, and the results of tests made on brickwork which, no doubt, was intended to represent usual workmanship, but which nevertheless was laid with the knowledge that it would be tested, should prove of value as well as of interest. Other tests of brickwork from actual construction have, to my knowledge, not been made, or at least not reported.

Watertown Arsenal Tests:

The most elaborate series of tests yet made on brickwork, so far as I am aware, is that made by the

TABLE 2

Tests on Brick Piers at Watertown Arsenal, U. S. Ordnance Department

Brick Used	Age		Ultimate strength lb. per square in.	
	Mos.	Days	Pier	Brick
Light hard, sand struck	2	12	900	....
Hard, water struck....	5	22	3,422	12,880
Light hard, water struck	5	5	1,565	5,828
Hard, sand struck.....	1	0	1,800	11,340
Light hard, sand struck.	6	0	1,519	6,598
Hard, sand struck.....	6	0	1,800	5,248
Light hard, sand struck.	6	0	1,224	4,474
Hard, sand struck.....	6	0	1,411	5,808
		Average	1,705	lbs. sq. in.

United States Ordnance Department at the Watertown (Massachusetts) Arsenal at various times since 1884. Disregarding those tests in which other than common brick were used and citing only such as were laid up in the same sort of mortar as used in our test specimens, namely 1:3 Portland cement mortar, I find the results, given in Table 2 of tests on eight piers, nominally 12" x 12" in area and 8 feet high, made in 1904 and 1905. The bricks used were from West Cambridge and East Brookfield, Massachusetts; Epping and Rochester, New Hampshire, and Mechanicsville, New York, and their crushing strengths, as determined from five specimens in each case, are also given in the table for such comparisons as may be desirable.

Bureau of Standards Tests:

Another series of tests suitable for comparison with our specimens is that made by the United States Bureau of Standards, in 1917, in the 10,000,000-pound Olsen hydraulic testing machine at Pittsburgh, Pennsylvania. Using again only those tests which were made on brickwork of common brick (Grade 2 of the series) laid in cement mortar, the results of these tests are shown in Table 3. The first item in the table represents masonry laid in a straight 1:3 Portland cement mortar; whereas the mortar of all the rest is also a Portland cement mortar of practically similar proportions, in which fifteen per cent of the cement by weight had been replaced by hydrated lime. The lateral dimensions of the piers varied from twenty-four to thirty-two inches; the height was approximately ten feet in all but those represented by the last items of the table, in which case the height was about five feet.

TABLE 3

Tests on Large Brick Piers, U. S. Bureau of Standards
(Age of brickwork one month in all cases)

Brick Used	No. of Tests	Ultimate strength lbs. per sq. inch		Per cent efficiency
		Brickwork	Brick	
Pittsburgh District....	3	1,647	6,070	27.2
Pittsburgh District....	3	1,463	6,070	24.1
New Orleans District..	2	1,710	6,880	24.9
New York District....	3	1,260	4,430	28.3
Chicago District.......	3	720	3,150	22.9
Pittsburgh District....	2	1,785	2,450	70.3
	Average	1,391	lbs. per	sq. in.

In this series the test on piers made from brick from the New York district should be especially noted. The brick used, it would appear from the crushing strength, can be said to be representative of the material to be found in the New York market and not especially selected for test purposes, as will be seen by a comparison with the average crushing strength, 3943 pounds per square inch, of a large number of Hudson River brick taken at random from various building operations in New York City, tested in 1905 at Columbia University for the Bureau of Buildings, New York. Compared with these figures the high values for the brick in the Watertown tests lead to the belief that special care was taken in selecting the specimens for the latter tests.

Columbia University Tests:

A series of tests, made by Professor James S. Macgregor at Columbia University, to determine the proportion of cement in mortar that might be replaced by lime without reducing the strength of the brickwork, is also interesting in this connection.

TABLE 4

Tests on Brick Piers Eight Inches Square and Seven Feet High, Columbia University

Mortar (mixture by volume)	Ultimate strength lb. per sq. in.
1 Portland cement, 0 hydrated lime, 3 sand	1,170
0.90 Portland cement, 0.10 hydrated lime, 3 sand	1,189
0.85 Portland cement, 0.15 hydrated lime, 3 sand	1,340
0.75 Portland cement, 0.25 hydrated lime, 3 sand	1,685
0.50 Portland cement, 0.50 hydrated lime, 3 sand	1,300
0.25 Portland cement, 0.75 hydrated lime, 3 sand	1,032

The piers tested were eight inches square and seven feet high, laid in mortar of varying proportions as shown in Table 4. Only the tests on the piers of common brick are included in the table.

Stockholm Tests:

Reference may perhaps also be made to some tests on brick piers made at the Technical High School in Stockholm, Sweden, and reported in the Clay Worker for July and August, 1917, as the crushing strength of the brick used, 4040 pounds per square inch, would seem to indicate a brick of about the same quality as those in use in New York City. Table 5 gives such results of these tests as are pertinent to our inquiry.

TABLE 5

Tests on Brick Piers at Stockholm, Sweden

Mortar Mixture			Crushing strength Pounds per square inch		
Cement	Lime	Sand	Piers	Brick	Mortar
1.00	0.00	3.00	1,980	4,040	2,620
0.43	0.85	3.00	1,930	4,040	1,640
0.67	0.33	3.00	1,700	4,040	1,280
0.50	0.50	3.00	1,840	4,040	695
0.33	0.67	3.00	1,420	4,040	355

Toronto Tests:

So far as I am aware, Tables 2, 3, 4 and 5 give all the available information with respect to the strength of common brick laid in 1:3 cement mortar, except the series made at Toronto, in 1918, under the direction of the building department of that city. But in that case concededly the poorest available bricks were used in the piers, a fact that is further evidenced in the low average crushing strength of the brick, about 1000 pounds per square inch, representing brick that would be rejected in the New York district as unfit for use. The highest value obtained for the strength of the brickwork was 780 pounds per square inch, the average of the seven tests being 601 pounds per square inch.

University of Illinois Tests:

The tests made at the University of Illinois (reported in Bulletin No. 27, September, 1908) are worth noting, but only two of the tests are included in our comparisons, as a different kind of brick was used in the other piers tested, namely a shale brick from Danville, Illinois, having a crushing strength (average of eighteen specimens) of 10,690 pounds per square inch. The clay brick used are described as underburnt clay brick from Champaign, Illinois, having a crushing strength (average of sixteen specimens) of 3920 pounds per square inch, that perhaps might be considered as making the results comparable with those of our tests. The piers were about twelve and a half inches square and ten feet high. The cases that are more particularly interesting in this connection where 1:3 cement mortar was used, are given in Table 6.

TABLE 6

Tests on Brick Piers at University of Illinois
By A. N. Talbot and D. A. Abrams

Brick	Brickwork	No. of tests	Age days	Strength lb. per sq. in.	Efficiency per cent	
					Brick	Mortar
Shale	Well laid	3	67	3,365	31	117
Shale	Well laid	2	181	3,950	37	....
Shale	Poorly ld.	2	68	2,920	27	105
Clay	Well laid	2	62	1,060	27	37

Table 7 Summarizes Tables 2 to 6:

A summary of the results given in these several tables is shown in Table 7. The last items of Tables 4 and 5, however, have been omitted from the sum-

mary, as there was a considerable difference between the mortar in those cases and that of our specimens. (Their inclusion would have lowered the general average by only fourteen pounds.)

TABLE 7

Summary of Tables 2 to 6

Table	Place of tests	No. of piers	Average strength lb.persq.in.	Comparative efficiency of specimens under investigation (1555 lb.) per cent.
2	Watertown Arsenal..	8	1,705	91.2
3	Bureau of Standards.	16	1,391	111.8
4	Columbia University.	5	1,337	116.3
5	Stockholm, Sweden..	4	1,862	83.5
6	University of Illinois.	2	1,060	146.7
	Total number of piers	35		
	General average strength		1,490	104.4

The results of Tables 4 and 5 were incorporated in this summary, although there is a variation in the mortars used by the substitution of lime for a part of the cement, because it seems from the tests that a certain admixture of lime with cement in mortar does not impair its strength, even if it were not admitted, as Table 4 might be held to show, that up to a certain point such use of lime increases the strength of brickwork. If it should be felt that the values given in Tables 4 and 5 should not be used in the general average, the summary would be 1462 pounds per square inch instead of that given.

Laboratory Strength Attained in Practice:

Keeping in mind the limited number of our tests, what, if any, conclusions may be reasonably drawn from these facts? This much, it is felt, can be confidently asserted, that the standard which has been used as the basis of investigation into the strength of brickwork, can be attained in practice. Our test specimens, as has already been stated and as may be seen from the photographs, did not represent unusual workmanship. Our specimens did not show any unusual variation in ultimate strength. In Table 8 the high and low values, compared with the average values, are given for our specimens and for three of the series already cited in which the same mortar was used. Although our specimens all came from one pier, a greater variation might have been expected due to the unavoidable rougher handling they had in removing them from the building, in handling and in transporting to the laboratory than the other specimens, which were built up especially for test and were probably not subjected to as much disturbance.

A variation in strength might have also been expected, due to position of the specimen in the pier from which it was taken. According to observations at some of the Watertown tests, failure was first manifested in the upper part of longer piers under test, which "was attributed to the consolidation which the mortar in the lower courses receives when first laid, from the weight of the brickwork above." Similar observations are recorded in the report of the tests at the University of Illinois. Unfortunately, in the trimming of our specimens for the testing machine, the identifying marks were obliterated and it is not now possible to say what positions the several specimens had in the pier from which they were taken.

TABLE 8

Summary of Test Results Where Same Mortar Was Used, Showing High, Low and Average Values

	No. of tests	Ave. stre'gth	Variation from Average			
			Highest		Lowest	
			Load lbs.	Per cent	Load lbs.	Per cent
Our specimens.......	4	1,555	2,093	134.6	877	56.4
Watertown Table 2...........	8	1,705	3,422	200.7	900	52.8
Pittsburgh........... Table 3...........	16	1,391	2,070	148.8	700	50.3
Univ. of Illinois...... Table 6...........	7	3,406	4,110	120.7	2,860	84.0

Further conclusions from the limited tests on actual brickwork that we here have, would hardly be warranted. It would not only be interesting but, I believe, useful to have additional information along the lines followed in this investigation. Opportunities offer from time to time for securing specimens from actual construction, a history and fairly complete knowledge of which is available. Their selection should be made with a view to covering as wide a field as possible with respect to material, workmanship and use.

Good Workmanship Vital:

However, the study of the results of our tests on actual brickwork in comparison with those made on prepared specimens, as they are given in the several reports already referred to, does seem to lead to the conclusion that good results are more dependent on workmanship than on the other elements entering into brickwork. If that is so, and it is believed it is, then efforts should be made to improve workmanship and to maintain a uniform standard practice.

In the report of the tests made at the University of Illinois considerable importance seems to be attached to the loads at which popping sounds were first noted while the specimens were under test. These popping sounds are "accredited to the breaking of the brick in flexure due to the stresses introduced by the readjustment of the different parts following unequal shortening in different parts of the column at a given level, or to uneven bearing of the brick throughout their length, or to both. The practice of bricklayers in placing mortar at the ends of the bricks causes them to be more fully supported at the ends (or not to have a uniform bearing throughout their length). As the same thing is done in the course next above and the joints are broken, the effect is that any given brick has a greater load in the middle and its main support is at the ends. This is particularly true of the inner portion of each joint in a column of small section." The report concludes, "It is apparent that the quality of workmanship in laying up such columns has an important bearing upon the resisting strength. * * * * Full joints and an even bearing are important, and the ordinary workman ought to be able to construct

columns of high strength. In the tests made on columns intended to represent poor or careless workmanship, the decrease in strength was not as much as anticipated. However, it must be understood that careful and trustworthy work is essential and that a few poor joints will materially reduce the strength of the structure. Wherever good material and good workmanship are insured, the strength of masonry of this kind may be utilized with advantage."

Bricks Should Have Even Bearing:

One of the conclusions in the report of the tests at the Bureau of Standards is "that variations in the number of header courses used do not have a positive effect on the compression strength of the pier." It is stated that the "opinion prevails that the tying in of the masonry with header courses helps to strengthen the pier against bulging action, thereby increasing the strength in proportion to the number of headers used. * * * * * In view of the tendency of the individual bricks to fail by flexure, it is believed that the bricks of the header courses are broken through at the joints before the pier has reached that point of failure when these bricks would prevent bulging of the outer rings." Failure of bricks by flexure occurs when the bricks do not have a uniform bearing. If they were so bedded that the pressures on the mortar joints below them were uniformly distributed they would undoubtedly make a better showing and the number of headers would then, perhaps, increase the strength of the brickwork.

The increase in efficiency due to uniform distribution of pressure through the mortar joints seems to be further confirmed by tests made on brickwork in which wire mesh was imbedded in the mortar joints, the wire mesh having the effect of distributing the pressures through the mortar. In the report on the Bureau of Standards tests the conclusion is drawn that "the strength of the pier may be increased by the introduction of wire mesh in all horizontal joints. The increase is slight, however, unless the mesh is used in every joint." A similar conclusion is drawn from a series of tests reported by Mr. E. J. McCaustland, in the Transactions of the Association of Civil Engineers of Cornell University for 1900. The fact that the piers in which the wire mesh was not used in every joint do not show great improvement does not vitiate the contention, but rather shows that the unreinforced joints, being the weak links, fixed the ultimate strength. The Cornell University tests show further that straps or plates inserted in the mortar joints do not help, which is, no doubt, due to the fact that straps and plates do not distribute the pressure more uniformly over the mortar than do the bricks. The results are shown in Table 9.

Further confirmation of the conclusion that a uniform distribution of the pressure throughout the mortar joint increases the strength and efficiency of brickwork, may be found in some tests made at the Watertown Arsenal in 1901, to study the effect of different cushions to be used in the testing machine. The results for the same kind of bricks are given in Table 10. From these figures it will be seen how the use of a thoroughly plastic material for bedding the brick gave higher strength value than the use of materials which do not readily adjust themselves to the irregularity of the specimen. In general the

TABLE 9

Effect of Various Types of Mortar Joint Upon the Efficiency of Brickwork as Related to Strength of Individual Brick

Place of tests	Kind of Joints	No. of tests	Average ultimate Strength		Per cent Efficiency
			Brickw'k	Brick	
Bureau of Standards Pittsb'gh	1:3 Portland cement mortar....	3	1,647	6,070	27.2
do.	1:3 Portland cement mortar in which 15% of cement was replaced by lime..	13	1,332	4,584	29.1
do.	do. with 18 gage No. 2 galv. iron wire mesh in every joint.....	1	2,270	2,450	92.7
do.	do. in every fourth joint....	1	1,470	2,450	60.0
Cornell Univer.	1:2 Portland cement mortar....	2	1,167	....	30.0
do.	do. wire mesh in every course....	2	1,567	....	46.0
do.	do. wire mesh in every second course.........	2	1,192	....	33.0
do.	do. iron plate every fourth course	4	1,002	....	28.0
do.	do. iron straps every fourth course	2	865	....	24.0
do.	do. iron straps every sixth course.	1	780	....	22.0
do.	do. iron straps every eighth course	1	843	....	24.0

more pliable cardboard cushions gave better results in the case of the large brick. In the case of the half bricks the results from the three methods were more nearly the same; a fact which would be expected as the surface over which adjustment takes place is so much smaller and the unevenness of the faces of the specimens was, no doubt, less marked than in the case of the whole bricks.

Full Bed Joints Mean Increased Strength:

The facts and opinions brought out in these several reports substantiate the point previously made that for better brickwork we must seek improvement in workmanship rather than in materials. The chief direction in which the improvement may be effected, as indicated by tests, would seem to be a more thorough filling of the joints in order to secure a full and even bearing so as to relieve as far as possible the flexural stresses in the brick and to get the advantage of the comparatively high compression strength of the brick. While the ultimate strength of brickwork (according to the records of the tests) does at times reach seventy to seventy-five per cent of the compression strength of the individual brick, that proportion is seldom over forty-five and more generally between twenty-five and thirty per cent.

Professor Macgregor's tests (Table 4) show that the strength of brickwork in cement mortar increases where lime to a limited extent is mixed with the

cement. These results are confirmed by other investigations. The increase in strength, however, is not due to any improvement in the mortar by

TABLE 10

Effect of Various Types of Cushion on Crushing Strength. All Bricks of Same Strength. Tests at Watertown Arsenal

	No. of tests	Average Breaking strength	Relative strength
Tests of whole bricks			
Set in plaster....................	7	9,060	100
*Set in cardboard cushions.......	7	7,380	81
Set in pine wood cushions.......	7	5,480	60
Tests of half bricks			
Set in plaster....................	14	5,640	100
*Set in cardboard cushions	14	4,430	79
Set in pine wood cushions.......	14	4,540	81

*The cardboard cushions were four thicknesses of 1/16″ on each side of the specimens, and the pine wood cushions were clear white pine ½″ thick.

the addition of the lime. Tests on the strength of mortar that have come to my attention are somewhat conflicting on the point, but they certainly are not convincing and would not justify any other conclusion. The improvement in brickwork by the use of lime in cement mortar, is, I believe, due to the greater plasticity of such mortar, permitting it to be more easily placed and spreading itself more uniformly through the joints as the bricks are laid, thus causing a more even bearing for the individual bricks and a more uniform distribution of the load that may come on the brickwork.

Conclusion:

The tests that were made on actual brickwork and which serve as the basis of this report show, as before stated, that it is possible to get in practice as good brickwork as we get in tests. With the co-operation of builders and mechanics (brick masons) brick manufacturers should study to improve brickwork so as to secure a higher ratio of efficiency of the finished product to the individual brick.

In the conduct of these tests and this study I wish to acknowledge the assistance of my former associate, Mr. George E. Strehan, consulting engineer, and Professor Albin H. Beyer, of the Columbia University Testing Laboratory. The investigations on brickwork now being conducted by the latter in co-operation with the Bureaus of Building of the City of New York have not been used in connection with this report, as the results are not yet available for that purpose.

FIRE-RESISTIVENESS OF COLUMN COVERINGS

Underwriters Tests:*

1. The most exhaustive fire tests ever made upon structural materials have been recently conducted jointly by the Associated Factory Mutual Fire Insurance Companies, the National Board of Fire Underwriters and the U. S. Bureau of Standards. Eight years, 1910-1918, were consumed in making these tests and the report was issued in December, 1920.

2. At the time the tests were made the common brick industry was unorganized, so that co-operation was impossible and the brick industry had no representative to suggest further tests upon its material Only one test was made with brick laid in the ordinary way and one test with brick laid on edge.

3. The test columns consisted of steel columns under load protected by various thicknesses of materials.

4. Only test results of brick and of the unfilled hollow clay tile protection upon which its fire resistance period is based are given here.

5. The test column was in each case 12 ft. 8 in. high.

6. The following were the outside dimensions of the hollow tile coverings. Test 48, 13½ in. square; test 49, 17½ in. square. Outside dimensions of the brick coverings were: Test 68, 13¼ in. square; test 69, 16½ in. square.

7. The mortar used for both hollow tile and brick consisted of 1 part by loose volume of Portland cement, 1 part lime putty and 4 parts fine beach or bank sand.

8. The brick in test 68 were laid on edge, the total thickness of protection being 2¼″. In test 69 the brick were laid flat, the thickness of the protection being 3¾″. Material under the following headings marked thus "*" is taken direct from the volume previously referred to.

*From "Fire Tests of Building Columns" published by the Underwriters' Laboratories, 207 East Ohio Street, Chicago, Ill.

Results of Fire Tests on Column Coverings.

Columns Protected by Unfilled Hollow Clay Tile

Test No.	Section	Protection: Thickness of Tile, In.	Protection: Kind of Tile, Filling, and Method of Tying	Age of Covering, Days	Load Sustained During Test, Lb.	Time to Failure, Hr./Min.	Furnace Exposure Per Cent
48	Rolled H	2	New Jersey semi-fire clay no filling Outside wire ties.	496	119500	1/50	100.9
49	Rolled H	4	Same as No. 48	497	119500	1/40	99.9

Columns Protected by Brick.

Test No.	Section	Thickness of Brick, In.	Kind of Brick and Filling	Age of Covering, Days,	Load Sustained During Test, Lb.	Time to Failure, Hr./Min.	Furnace Exposure, Per Cent
69	Rolled H	3¾	Chicago common brick laid flat, Brick fill	502	119500	7/13¼	101.2
68	Rolled H	2¼	Chicago common brick set on edge, and end, Brick fill	498	119500	1/40¾	104.0

*Discussion of Test Results of Brick.

9. "In No. 69 with the brick laid flat, little cracking or spalling developed before failure. Fusion of the brick began between the fourth and fifth test hours, and after test the brick was found fluxed away to a depth of about one-half inch. The uniform temperature rise in the metal indicates that the fusion of the brick did not contribute greatly to the failure of the column, the same being evidently caused by normal transmission of heat through the covering.

10. "In No. 68 where the brick was set on edge and end, the lack of stability considerably shortened the test, a large amount of brick falling during the first 30 min."

*Fire Resistance Period, How Derived

11. "A given resistance period is taken to hold, if the time to failure in the fire test, or the average of the time to failure in a group of similar tests, is equal to one and one-half times the given resistance period. The deduction of one-third of the test duration is made to allow for incidental variations in material and workmanship of columns and coverings, and differences in load and fire conditions that cause variations in results with nominally comparable columns."

*Fire Resistance Period, Unfilled Hollow Tile Protection

12. "Structural steel columns with hollow clay protections of 2-in., 3-in. or 4-in. semi-fire clay tile of medium hardness, tied with outside wire ties, give **one hour** fire resistance.

"This period is based on results of fire test Nos. 48 and 49 taken together with fire and water tests Nos. 105 and 107. The tile in these tests developed fewer disruptive effects on exposure to fire than any other kind tested. Tile more sensitive to abrupt temperature change is not adapted for use in unfilled protections, as the cracking and spalling resulting after a short fire exposure allows the heat to readily reach the steel, also on application of water, parts of the impaired covering are liable to be carried away, leaving the metal unprotected against a possible recurring fire.

13. "The use of unfilled protections should generally be avoided as the filling materially increases their stability and insulating value."

*Fire Resistance Period, Brick Protection:

14. "Structural steel columns protected with common surface clay brick laid flat on side to form a solid protection of about four inch thickness, develop **5-hour** fire resistance, and with brick set on edge and end outside of the flanges and edges, and filling the whole space to the steel, **one-hour** fire resistance is developed."

Fire Resistance Period Necessary to Qualify:

15. To qualify as fire resistive, it is generally considered that any material must be given at least a four hour rating.

Brick on Edge Column Protection:

16. The brick on edge in this test were not held in place by anything except the bond of the brick at the corners of the pier.

17. It is the belief of the author that if a tie wire were placed in each or alternate horizontal courses, extending in one piece around the column and lapping over at the ends, that 2¼" brick on edge column protection would fulfill the requirements for a four hour rating.

HEAT EXPANDS BRICK LEAST

1. From the following table below it will be noted that brick masonry expands less under heat than any other type of masonry, a fact which should be taken into account when selecting the materials for fire resistive walls, for with less expansion there is less chance for buckling at high temperatures.

2. To find the increase of a bar due to an increase in temperature from the table, multiply the length of the bar by the increase of degrees and by the coefficient for 100 degrees, and divide by 100.

†Coefficients of Expansion of Various Materials.

For 100 Degrees

Substance	Linear Expansion: Centigrade	Linear Expansion: Fahrenheit
Ashlar masonry	.00063	.00035
Brick masonry	.00055	.00031
Cement, Portland	.00107	.00059
Concrete	.00143	.00079
Concrete masonry	.00120	.00067
Granite	.00084	.00047
Limestone	.00080	.00044
Marble	.00100	.00056
Plaster	.00166	.00092
Rubble masonry	.00063	.00035
Sandstone	.00110	.00061
Slate	.00104	.00058

†Pocket Companion, Carnegie Steel Co., Page 377.

MATERIALS USED IN BRICK CONSTRUCTION

BRICK

Definition:

1. A brick is a solid building unit of burned clay.

2. **Common brick** has a natural surface, in distinction to **face brick,** in which the face is roughened or otherwise treated to produce special effects in texture or color.

Brick Clay:

3. Brick is made from an argillaceous earth, purified and refined by nature by processes extending over millions of years. The raw material has passed through tests such as we can hardly dream of in this age. Brick clay has successfully withstood great convulsions of nature, terrific heat and glacial action, and has amply proved itself to be practically indestructible. The action of fire upon solid shapes of clay moulded into brick form increases, if possible, this quality of indestructibility. Modern villages built near the ancient city of Babylon are constructed from bricks found in its ruins, dating back several thousand years B. C.

4. Most brick are made from surface clay, dug by steam shovels or by hand from open clay pits. Other brick are made from incipient shales which are often mined.

Methods of Brickmaking:

5. There are many methods of preparing the clay; of forming the shapes; and in methods of burning. The process followed in each locality depends on the characteristics of the clay and kind of brick desired.

6. **Pressed brick** are made by the dry press or re-pressed method. Pressed brick have a fine smooth surface with true angles and corners.

7. **Dry press** brick are made by pressing practically dry granulated clay into moulds under terrific pressure. Pressed bricks were formerly set in kilns without further drying, and burned.

8. **Re-pressed brick** are first pressed as described for dry pressed brick, but the moulds are a little larger. The brick are then dried and pressed again into smaller moulds before being burned.

9. **Soft mud** brick are divided into two classes—**sand mould** and **water struck.** The clay is mixed with water and pressed into moulds, the excess clay being struck off level with the top of the mould. To prevent the wet clay adhering to the mould, either the latter is dashed with sand—producing **sand mold** brick; or the mould is wet—producing **water struck** brick. The brick are then dried, either in the open air or in special dryers and set in the kiln.

10. **Stiff mud** brick are divided into two classes—**end cut** and **side cut.** They are made from stiff clay forced through a rectangular die, issuing in the form of a continuous bar, cut off to proper length by wire cutters. If the clay bar has the cross section of the width and thickness of a brick the wire cuts the bar to the proper **length** (end cut brick). If the clay bar has the section of the width and length of a brick the wire cuts the bar to the proper **thickness** (side cut brick.) The brick are dried in the same manner as soft mud brick.

11. All brick are burned, being exposed for several days to terrific heat—the temperature of a kiln averaging about 2000 degrees Fahrenheit.

Visit a Brick Plant:

12. Although improved methods of manufacture have been introduced within recent years, the basic principle is the same as that handed down through the centuries, a valued heritage from antiquity.

13. There are few processes so interesting to the architect, engineer, builder and technical student, and few that will so well repay a visit by developing a better understanding of the various grades of a local and easily available product. Brickyards are easily accessible in every part of the country and visitors to plants of members of the Common Brick Manufacturers' Association are always welcome.

Size of Brick:

14. The standard size of all building brick—face and common—is 8″x2¼″x3¾″. It is understood that a reasonable variation is allowed, for clay generally shrinks in the process of burning, and brick from the middle or hottest part of some kilns may be ⅛″ to 3/16″ shorter in length than brick from the outside or cooler portion of the same kiln.

Color of Brick:

15. Owing to differences in the chemical composition of clay, the color of brick varies considerably in different parts of the country; oxide of iron and lime being the chief factors which influence it.

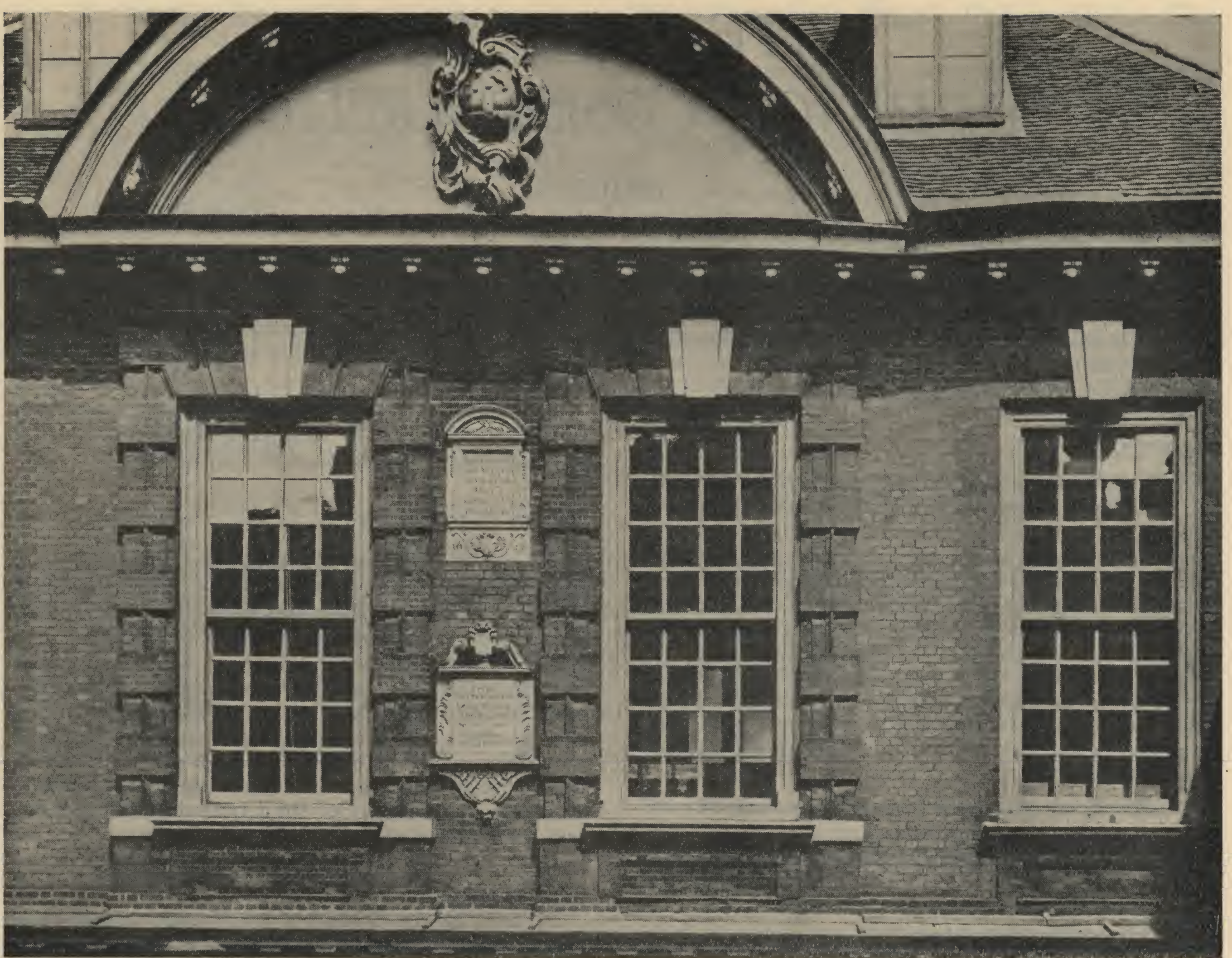
16. To a lesser extent the degree of heat to which the bricks are subjected while burning also affects the color, but the presence or absence of any particular color is not always indicative of their hardness. Any good mechanic will lay only the hardest bricks to the weather.

Weight of Brick:

17. This varies greatly with the clay. The average common brick of standard size weighs, however, about 4½ lbs. For average weight of laid brickwork for solid walls see Table 1, page 9.

Bulk of Loose Brick:

18. One thousand brick closely stacked occupy about 56 cu. ft. of space.



Detail of the Guildhall, Rochester, England, Built 1687.

Selecting Exposed Brick:

19. To avoid misunderstanding, the grade and color effect of brick supplied for facing should preferably be determined by examples of laid work in an actual building. If this is not possible, the next best method is to select the brick from sample panels—the larger the better. It should be remembered always that even a slight change in the color, width, or cross section of the mortar joint will modify the appearance of the finished wall. It is seldom satisfactory to use a few loose brick for samples. The eye of an expert is needed to judge their exact effect when actually laid, and moreover the full beauty of brickwork is not realized when the mistake is made of selecting the brick so that they match each other exactly in shade.

Selecting Unexposed Brick:

20. Brick for unexposed work are not supplied by sample but by the name of the grade required—these names varying in different localities. The manufacturer will always gladly co-operate by supplying a suitable grade for the particular use and location in the building for which the brick is, intended.

Soft or Salmon Brick Has Its Uses:

21. The attention of architects, builders and specification writers is particularly directed to the fact that it is a mistake to require that only the hardest burned brick be supplied to every job. Soft or underburned brick has enormous strength. See test results on preceding pages.

22. The outside courses of all walls exposed to the weather, foundation walls, walls and piers required to carry very heavy loads—as in many commercial and engineering structures—should always be laid in hard burned brick.

23. But for much interior work, backing up of walls faced with harder burned brick; for fire, party and division walls; and in general any location where absorption is not a factor and where great strength is not required; advantage may be taken of the lower cost and sound serviceability of soft or salmon brick.

24. Salmon brick has an unexcelled bonding surface on which to plaster direct.

Appearance of Brickwork:

25. As a result of a demand for special effects in exposed brickwork there has been developed an industry of considerable magnitude—the face brick

industry. Face brick manufacturers are able to supply a brick of any color or variety of colors desired, and by scratching or other treatment of the surface can produce any texture. In most parts of the country building material dealers can supply face brick. In other sections bricks for facing are customarily selected from the harder burned brick delivered to the job, or are marketed in special selections by the manufacturer.

26. In an ordinary residence the quantity of face brick required for the outer course is not great, and even if the best grades of face brick are selected, the additional cost will not add a great deal to the total cost of the house.

27. A well built wall of hard burned brick produced in any locality will have a most interesting and beautiful appearance if the brick are carefully laid with proper bond and due consideration given to the width, section and color of the mortar joint.

28. Many large and important structures, carefully designed as to front elevation, are built with side and rear walls fully exposed, upon which little thought has been given as to design, and little care in the laying of their common brick surfaces, on the assumption that at some future time they will be masked by other buildings.

29. In passing judgment upon the appearance of a wall built of common brick, due consideration should be given the fact that far too frequently such walls are laid carelessly, the individual bricks being capable of producing a much better effect if the same care is used in laying them that is accorded any other facing material.

30. In some localities residences are constructed with face brick on the street front only, and perhaps for two or three feet on the return. Beauty has an economic value and a far better looking group of homes would result if the same material were used all around.

Brick Harmonizes Well with Other Materials:

31. Brick harmonizes well with stone and terra cotta and beautiful designs may be worked out using these materials for quoins, belt and string courses, cornices, etc. Care should be taken that the contrast between the brick and the trim is not too great.

32. Stucco panels are sometimes used with brickwork and may be made effective. The brickwork behind the stucco should be recessed so that the face of the stucco is flush with the brick, to prevent water finding its way between brick and stucco at the top and sides of the panel.

Sorting Brick:

33. Where the face of the wall is to be laid of selected brick sorted out from the ordinary brick at the job, always locate the brick pile so that the man who is sorting can work in the shade. He will do faster and better work in the shade than in the sun.

CEMENTS AND LIMES

1. Only the widely used and most available mortar materials are here described.

Portland Cement, Strength:

2. Standard specifications of the American Society for Testing Materials require that a briquette of 1 part Portland cement to 3 parts sand by weight must have a minimum tensile strength of 200 lbs. sq. in. 7 days old, stored 1 day in moist air and 6 in water; and 300 lbs. sq. in. 28 days old, stored 1 day in moist air and 27 in water.

Portland Cement, Volume and Weight:

3. A bag contains 94 lb. net. A barrel contains 4 bags or 376 lbs. net. Packed, its weight averages 108½ lbs. per cu. ft.; loose, 92 lbs. per cu. ft.

4. Portland cement should be kept from dampness. It is well worth while to keep empty cloth bags dry. An allowance is made for bags returned in good condition.

Natural Cement, Description and Strength:

5. While natural cement is used successfully by some contractors who carefully follow manufacturers' directions, it has several objectionable qualities. It is a variable product; and it sets so rapidly that it must always be retempered before placed in the wall. Bricklayers, in fact, prefer to use it when retempered, since this increases its plasticity, but at the same time seriously reduces its strength. (Par. 23, page 62.)

6. Natural cement is not as strong as Portland cement; 1:1 natural cement mortar having about the same strength at the end of one year as 1-3 Portland cement mortar.

7. A bag contains 94 lbs. net; a barrel 282 lbs. net.

Lime, General Description:

8. Quicklime is formed by calcining limestone. It comes from the kiln in lumps and in that form is marketed under the trade name of **lump lime.** When hydrated or slaked at the plant it is called **hydrated lime.** Lime is occasionally supplied in the form of pulverized or ground quicklime.

Lump Lime, Classification:

9. There are four classes; high-calcium, calcium, magnesian, high-magnesian; the two latter also being termed "dolomitic" limes. Calcium and high calcium limes are more generally available than magnesian types. "Fat" or rich lime is more than doubled in volume when slaked. The paste is very smooth to the touch. It will carry a great deal of sand and because of its great plasticity works with great ease under the trowel, and is more economical

than lean lime. "Lean" or poor lime increases to less than twice its volume when slaked, carries less sand, and while fairly plastic is less so than fat lime.

10. Each of the four classes previously mentioned includes limes of the "fat" and "lean" varieties.

11. There is little difference in the strength of high calcium and dolomitic lime mortars. It is the custom to use the class of lime most available in the locality.

Lump Lime, Grades:

12. **Selected** is well burned, picked free from ashes, core, clinker or other foreign material. This is the better grade to order for brick mortar. **Run-of-kiln** is well-burned, without selection. Pulverized lime must pass a ¼-inch screen.

13. Do not accept lime that is old or air slaked. Fresh lime is in hard lumps with little powder. Air slaked lime is mostly powder and lumps are soft and crumbly. When water is added, lime should slake into a fine smooth paste without leaving any residue.

Lump Lime, Volume and Weight:

14. A bushel contains 75 to 85 lbs. net. A cubic foot weighs from 60 to 65 lbs. A 180-lb. barrel contains about 3 cu. ft. A 280-lb. barrel contains about 4¾ cu. ft. In this book the 180-lb. barrel is always referred to.

15. As a rough average, a 180-lb. barrel of good lime makes about 7.05 cu. ft. of putty.

Lump Lime, Storage:

16. It is advisable to slake lime as delivered and not store it. Before being slaked, it must be kept dry and prevented from absorbing moisture from the atmosphere or it may become useless. If stored, keep in a dry covered place in barrels or in an air-tight box if in bulk. The box should be fitted with a door in the lower portion for easy removal of material.

Hydrated Lime, Description:

17. Hydrated lime is a fine dry powder. It is particularly useful where space on the job is limited and there is not sufficient room to stack a supply of sanded lump lime paste; also where the time required to prepare lump lime paste is a consideration. It is of particular value where, owing to carelessness or lack of skill, lump lime might be spoiled in slaking. Hydrated lime may be more quickly and accurately proportioned than lump lime.

Hydrated Lime, Volume and Weight:

18. A cubic foot weighs 40 lbs. A paper package contains 50 lbs. net. A cloth package contains 100 lbs. net. The 50 lb. package is most generally supplied. Sold also in bulk by the 2,000-lb. ton.

19. Hydrated lime makes about 1.14 cu. ft. paste per 50-lb. bag.

Patent Brick Mortars:

20. There is a large variety of brick mortars and trademarked brick cements now on the market. Some consist of Portland cement, lime and sand mixed dry and sold in bags. Others consist of natural cement mixed with hydrated lime or Portland cement. One brand of brick cement used widely in the Middle West is a natural but non-hydraulic cement, slow-setting (can be retempered the next day), swells about half in volume soaked in water, and tests show it very strong when fully set.

21. The previous performance and actual properties of any patent brick mortar should be carefully investigated and it should be used according to manufacturer's directions.

SAND AND MORTAR COLORS

Sand, Description:

1. Sand should be clean, with sharp angular particles free from vegetable matter, loam, large stones and dust. Pit sand makes the best mortar. If it cannot be obtained, good sharp sand can be often found in river beds. Sand with rounded particles makes weaker mortar than sharp sand.

2. A simple test for cleanliness is to squeeze some wet sand in the hand. If loam is present the sand will retain its shape. If not it will have a gritty sound and rubbed on the palm will not leave a slimy deposit. Another test is to place some of the sand in a glass bottle with water, the level of the water being an inch or two above the top of the sand. After settling, most of the loam will be at the top of the sand.

3. A small amount of organic impurities will decrease the strength of the mortar and if sand contains over 5 per cent. of loam the strength of the mortar will be very seriously reduced and such sand should not be use unless first washed.

Coarse Sand Makes Densest and Strongest Mortar:

4. Recent tests by A. N. Talbot at the University of Illinois on mortar made with coarse, medium, fine, and very fine sand show that with very coarse sand the mortar has the least percentage of voids, and with very fine sand the highest percentage; the medium also has a lower percentage than the fine; the amount of water being equal in each case. Mortar containing fewest voids is strongest, and is best obtained by using a well graded sand.

Sand, Screening:

5. Sand should always be screened or much time will be lost by the bricklayers having to dig out larger stones while spreading mortar. Use a screen with a long vertical spacing and narrow horizontal spacing. It will screen the sand faster than a screen with square openings. A No. 4 screen, with four meshes to the inch, is most commonly used.

Sand, Volume and Weight:

6. Sand is sold in some localities by the cubic yard (27 cu. ft.). In other sections it is sold by the 2,000-lb. ton; approximately 20 cu. ft.

7. A cu. ft. weighs approximately 100 lbs. A one-horse load is about one yard or 27 cu. ft. A two-horse load varies from 2 yards to 2½ yards; the former being a fair, the latter a large load.

Natural Mortar Colors:

8. Mortar may be colored by using colored sand, ground granite or other stone and where the desired shade can be thus obtained these are preferable to artificial colors, because natural sands and stones have an unquestionably permanent color and do not weaken mortar. The color of the sand in the finished joints will be modified, however, by the uncolored cementing material which appears between and covers some of the sand particles.

9. Pure white joints may be obtained with white sand, ground limestone or marble.

Artificial Mortar Colors, Description:

10. Special care should be taken to select good artificial mortar color. In some districts contractors have a habit of ordering from hardware stores indefinite products such as venetian red, yellow ochre and lamp black for use in mortar. These colors may or may not be good; many expensive pigments being unsuited for such use. Mortar has a strong alkaline action and coloring materials should be chemically inert or the color may fade or run when in the wall. Mineral colors are preferable. Mortar color should be obtained from a reliable building material dealer and a brand selected that has actually stood the test of time, manufactured by a thoroughly responsible concern. Any artificial mortar color will fade somewhat in the sun, however. (See also pars. 17-18, page 70.)

Artificial Mortar Colors; How Supplied:

11. Artificial mortar colors are in two forms, pulp or paste, and dry powder. Pulp colors are more expensive than dry powder and have not as much coloring power per unit of weight. They are easier to use because less labor is required to thoroughly incorporate them with the mortar.

Artificial Mortar Colors; Quantity Required:

12. Manufacturers' or dealers' directions should be followed as to quantity. The more thoroughly color is mixed less is required to produce a given shade. The amount required depends also on the color used. As a fair average, it takes upwards of 100 lbs. dry powder per thousand brick in a solid wall with ½-inch joints. For pulp color add 20%. For Ideal all-rolok walls 50% of the amount needed for a solid or Ideal rolok-bak wall is ample.

13. Some dealers, to emphasize the efficiency of the particular brand of color they deal in, recommend the use of comparatively small quantities. If colors are very thoroughly mixed, smaller quantities may accomplish the purpose, but to avoid disappointment it is better to order an ample quantity, especially as the difference in cost is slight.

14. Figure an amount necessary to lay the outer course and a little over. If the bricklayer runs out of uncolored mortar, it is cheaper to have him continue work and lay the back of the wall with colored mortar, than to stand and wait for uncolored mortar.

Mixing Colored Mortar:

15. Mix the mortar to a stiff consistency when using artificial colors. If color is added after the mortar is made, much more labor is necessary. Never mix mortar colors with hot lime, for hot lime will bleach out the color.

16. Dry colors, when soaked a few days, will mix more easily with the mortar and go further than when mixed dry; in fact, it is advisable to have a barrel in which to keep a supply of dry color mixed with water. When required, stir with a stick and bail out the quantity required.

Colored Mortar, Strength:

17. Although artificial colors may reduce the strength of mortar by adding to the fine matter in its composition; brickwork has such a high factor of safety that for ordinary purposes this slight reduction in strength need not even be considered when good colors are used.

Selection of Colors:

18. The same procedure for selecting colors should be followed as for selecting brick (Page 58, par. 19).

SELECTION AND PREPARATION OF MORTAR

Function of Mortar:

1. A brick wall is bound together in two ways; first by the mechanical bonding or overlapping of the brick, and secondly by the properties of the mortar. The strength of brickwork is thus doubly safeguarded. Brick itself has an enormous factor of safety, and any well bonded wall will safely bear considerable loads. Good mortar is essential to good brickwork and a wall with poor mortar will not carry the loads that are possible when the mortar is up to standard, or be as satisfactory; but with brickwork a poor batch of mortar does not ordinarily involve the risk of failure.

2. Mortar in horizontal joints provides an even bed for supporting the courses above, and in all joints serves to unite the brickwork into one mass by its adhesive properties and prevents the penetration of wind and weather between the brick units.

Selecting Mortar:

3. Three factors should be considered (**a**) the required strength and exposure of the brickwork, (**b**) the cost of the mortar itself, (**c**) the degree of its plasticity. With a smooth easy working mortar more brick can be laid in a day by each bricklayer. This smoothness generally depends upon the amount of lime which it contains.

Mortar for Wide Exposed Joints:

4. It is difficult to lay brick on a bed of soft mortar ¾" thick and over; and to stiffen the mortar as well as to form a rough granulated texture, very coarse sand or even fine gravel should be mixed with the sand, the size of the particles increasing with the thickness of the joint.

Portland Cement Mortar, Where Used:

5. Is recommended for piers or walls which carry heavy loads, for wet or very exposed situations, fire

and party walls, work under water, brick footings, sills, chimney and parapet caps, free standing chimneys above roofs, brick steps, cheek walls to steps, brick porch and terrace floors and similar exposed locations and for use in freezing weather.

6. It is sometimes used throughout a building. It is the highest in cost of all the mortars.

Portland Cement Mortar, Composition:

7. Mortar composed of Portland cement and sand is not plastic. It works "short" and some is wasted because much of it near the edge of the bed rolls off. Laying brick with pure Portland cement mortar is slow and difficult and the bed joints are not so thoroughly filled as with a more plastic mortar. Thus, although pure Portland cement mortar is the strongest, the actual brickwork may not be as strong as when part of the cement is replaced with lime.

8. About 10% by weight of the cement is generally replaced by dry hydrated lime or its equivalent in lime paste. When so proportioned it is generally called "Portland cement mortar" in distinction to "Pure Portland cement mortar." This proportion is figured in the tables at the end of the book.

9. A good proportion for first class mortar is one part Portland cement (of which part is replaced with lime as above) to three parts sand, by volume.

Cement-Lime Mortar, Where Used:

10. Cement-lime mortar will set in damp places but is not as weather resistive as Portland cement mortar. Consequently, for wet places and very exposed situations, such as freestanding chimneys above roofs, the latter is preferable.

11. We especially recommend cement-lime mortar made with Portland cement for use in constructing Ideal walls above and below ground.

12. It is also generally recommended for masonry carrying heavy loads, for all solid residence walls above footings, for fireplaces and flues, (par. 28, page 85) and for locations where the work is partially protected, such as veranda posts and piers.

13. Cement-lime mortar costs less than cement mortar but more than lime mortar.

Cement-Lime Mortar, Composition:

14. Cement-lime mortar is plastic and works smoothly and easily under the trowel, and produces brickwork of high strength. As many brick can be laid per day with this mortar as with lime mortar. It is similar to Portland cement mortar above described, except the proportion of lime is greater. A mix that proves very strong and economical is a 1:1:6 proportion.

15. Natural cement can be used instead of Portland cement but makes a weaker mortar, although possessing ample strength for ordinary structures. The lime delays its naturally quick initial set and makes it a more usable material for brick mortar. Manufacturer's directions should be followed for exact proportioning.

Cement Mortars, Preparation:

16. In mixing cement or cement-lime mortar the cement and sand should first be mixed thoroughly while dry. Hydrated lime, if added dry, should also be mixed with the dry cement and sand. This is best accomplished by spreading the material in thin layers one over the other in one end of the previously cleaned box, and turning the mixture over three or four times with shovels or hoes.

17. If lump lime paste is added, it should be slaked and aged several days before it is mixed with the cement. Never mix hot lime with cement, for hot lime weakens it. (See par. 40, page 63.)

18. The mixture should be hoed from end to end of the box until thoroughly incorporated. The consistency should be such that the hoe is clean when withdrawn from the mortar.

19. There is danger in using too much or too little water. An excess "drowns" the cement, retards setting and weakens the mortar. Too little water will weaken or even spoil the mortar.

20. Cement or cement-lime mortar should be used without much delay and made in small batches as required. (See also pars. 22-26.) There should be no mortar left overnight. It will be useless the next day.

Natural Cement Mortar:

21. Natural cement mortar may be used in walls or piers carrying heavy loads which will not be exposed to dampness for one month after being laid. It should not be used in very exposed situations.

Retempering Cement Mortar:

22. Specifications usually read that cement mortar shall not be retempered after taking its initial set. When larger quantities of mortar are mixed than are required immediately, however, the usual custom is to retemper it, adding water that may have disappeared by evaporation.

23. Retempering makes cement mortar more plastic and delays the final set. It seriously decreases the strength of quick setting cements, such as natural cement. Prof. Ira O. Baker* states that natural cement may lose 30 to 40% strength by retempering after standing 20 minutes and 70 to 80% after standing 1 hour.

24. With a slower setting Portland cement, the loss of strength is probably not serious if the mortar is retempered immediately after the initial set. Tests mentioned by L. C. Sabin† show that retempering is not deleterious to the tensile strength of Portland cement mortar if it is retempered several times during the period in which it is standing. It should not be allowed to stand undisturbed for any length of time. The loss of strength is greater with fine sand than with coarse.

25. Retempered mortar shrinks more than ordinary mortar in setting and may cause small cracks to appear on the surface of the joints. Mortar insufficiently mixed may have its strength increased by retempering.

26. The safest procedure is not to use mortar which has taken initial set, especially natural cements and quick setting varieties of Portland cement.

Lime Mortar, Where Used:

27. Lime mortar is recommended for house construction above ground, except where very heavy

* "Treatise on Masonry Construction" page 100.
† "Cement and Concrete" page 252.

loads have to be carried on brick piers, or where walls are much cut up by window or door openings, or in very exposed situations. It is the lowest in cost of all the mortars.

28. It should not be used for exterior basement walls subject to a great deal of dampness, unless the wall is thoroughly water-proofed outside, because excessive dampness, if long continued, makes it lose its binding properties.

29. Straight lime mortar should never be used for fireplaces and flues.

30. Lime mortar hardens slowly and gets stronger with age.

Lump Lime, Preparation:

31. It is slaked by being placed in the mortar box and adding water. It becomes very hot, giving off vapor and bursting into powder which reduces to a paste called lime putty.

32. Every lime requires slightly different manipulation and the best results can be obtained by following manufacturer's or dealer's directions, in the absence of which these suggestions are made. Experience is the best teacher and experienced labor should be used for this purpose.

33. The higher the percentage of calcium the more quickly the lime slakes and the more heat is generated. Calcium limes are known as quick slaking limes. A magnesian or high magnesian lime will slake more slowly, combine with less water, generate less heat, undergo less increase in volume, set more slowly, and shrink less than a high calcium lime. Magnesian limes are known as slow slaking limes. High calcium limes may slake in a few minutes; high magnesian limes may take half an hour.

34. With quick slaking lime always add lime to the water, with medium limes add water to the lime. Care must be taken with quick slaking lime to have sufficient water in the box before the lime is shovelled in to prevent "burning" or overheating. Hoe thoroughly and quickly and add more water at the slightest appearance of escaping steam.

35. With slow slaking limes the danger lies in putting on too much water. Just moisten a slow lime at first, cautiously adding more water as slaking proceeds. Do not hoe until slaking is practically complete. Use hot water in cold weather, or if this is not practicable keep the mortar box covered.

36. "Burned" lime is granular, non-plastic and will not bind the sand together; "drowned" lime is lumpy and watery. Both are practically useless for making mortar.

37. The laborer should have a good supply of water. A barrel of water and a pail should be handy for quick action if the lime starts to burn.

38. As soon as the slaking process is complete, mix the sand with the paste and shovel it out on the wood platform, to remain until it is tempered for use.

39. Sometimes where a poorer grade of lime is used, there is a residue of impurities after the lime is slaked. In such cases slake the lime in a separate box, afterwards screening it into the mortar box and mixing it with the sand. Such lime does not generally make so strong a mortar as that which leaves no residue. It is a cheaper grade and for that reason is used for much ordinary low cost work.

Seasoning Lime Putty:

40. Lump lime should generally be slaked at least one week before being used. This is a safe rule to follow, although some limes can safely be used two or three days after slaking. At the time of slaking, some of the lime particles may escape the slaking process. If the mortar is mixed and used too soon these particles of free lime will afterwards take up water, causing the mortar to be crumbly and to "pop". Ageing lime paste enables it to carry more sand.

Hydrated Lime; Preparation:

41. Most frequently hydrated lime is mixed directly with the sand. When so mixed it does not trowel so easily as mortar made from lime putty. The working qualities of the hydrate can be improved by allowing the mortar or paste to soak over night. Hydrated lime does not require slaking.

Proportioning the Sand:

42. There is no set rule regarding the proper proportion of sand to lime. If there is too much lime in the mortar, it sticks to the trowel. If there is too much sand, it is stiff and difficult to work. If the sand particles are very fine, more lime will be required. Experience is the best guide to the proper proportioning. The sand quantities in the tables must be regarded as approximate only.

Tempering Lime Mortar:

43. When the sanded and stacked lump lime paste is required for mortar, it is shovelled back into the mortar box and "tempered" for use. This is done by adding water and working it to proper consistency, a condition reached when the mortar slides easily off the trowel. It should be hoed from end to end of the box until the lime is thoroughly distributed throughout the mass. If lime is left in spots or small masses, the mortar will not be as strong or as efficient.

LABOR MAKING MORTAR

1. All labor required to slake lime and mix mortar is included in the item "laborer's time" in the tables at the end of this book. The following information may, however, be found useful.

Labor Slaking Lime:

2. A laborer with some experience in making mortar should be able to slake, sand and stack about 1⅜ barrels of lime per hour or 11 barrels per 8 hour day.

Labor Mixing Mortar:

3. The time required for mixing and tempering mortar per 1000 bricks varies from 1 to 1½ hours, depending on the thickness of the mortar joints. These figures apply both for lime and cement mortar. For lime mortar it also includes the time required to slake the lime. One mortar maker should supply 8 bricklayers. With a power driven mortar machine one man can supply from thirty to fifty bricklayers, but of course will require some assistance in having sand, etc., wheeled to the machine. It is long run economy to have expert mortar mixers and to keep the bricklayers amply and carefully supplied with mortar as well as bricks.

EQUIPMENT FOR MORTAR MAKING

(See also "Equipment for Brick Construction", pages 85 and 86.)

Mortar Bed:

1. For mixing mortar, there should be provided a watertight mortar bed or box. This is sometimes built as illustrated below. With this type of box the bed is made by spreading a three or four inch layer of sand on the ground. On this lay three 2″ x 10″ planks the width of the box. On these planks lay at right angles the 2″ x 10″ planks forming the floor. The sides and ends of the box (which are permanently nailed together) should then be placed on the bottom and the corners and any holes in the bottom plastered with mortar to prevent the escape of cement or lime putty. A box of this kind being made of several pieces is easily taken from one job to another.

2. Other contractors prefer to build a box of thinner and lighter material permanently nailed together —some using 1″ boards. The bottom is then supported on three or four pieces of flat 2 x 4 placed crosswise of the box and nailed on permanently.

Colored Mortar Box:

3. Where only a small amount of colored mortar is to be used it is sometimes mixed at one end of the large mortar box. In some cases a board is used to partition it off for this purpose. Where a larger quantity is required a separate colored mortar box should be used, the regular size being about three feet by six feet; constructed of light material so it can be moved from one job to another.

Platform:

4. Where lump lime is used a platform for stacking mortar is provided, for lump lime should be slaked when it comes on the job and in any case a week's supply must be kept on hand.

5. This platform may be constructed of loose plank as described for the first type of mortar box, the planks resting upon one or two other plank laid at right angles, supported on sand.

Lime Bed:

6. To age a large quantity of lime paste some contractors simply spread a thickness of sand on the ground with a depression in the middle, in which the slaked lime is stored.

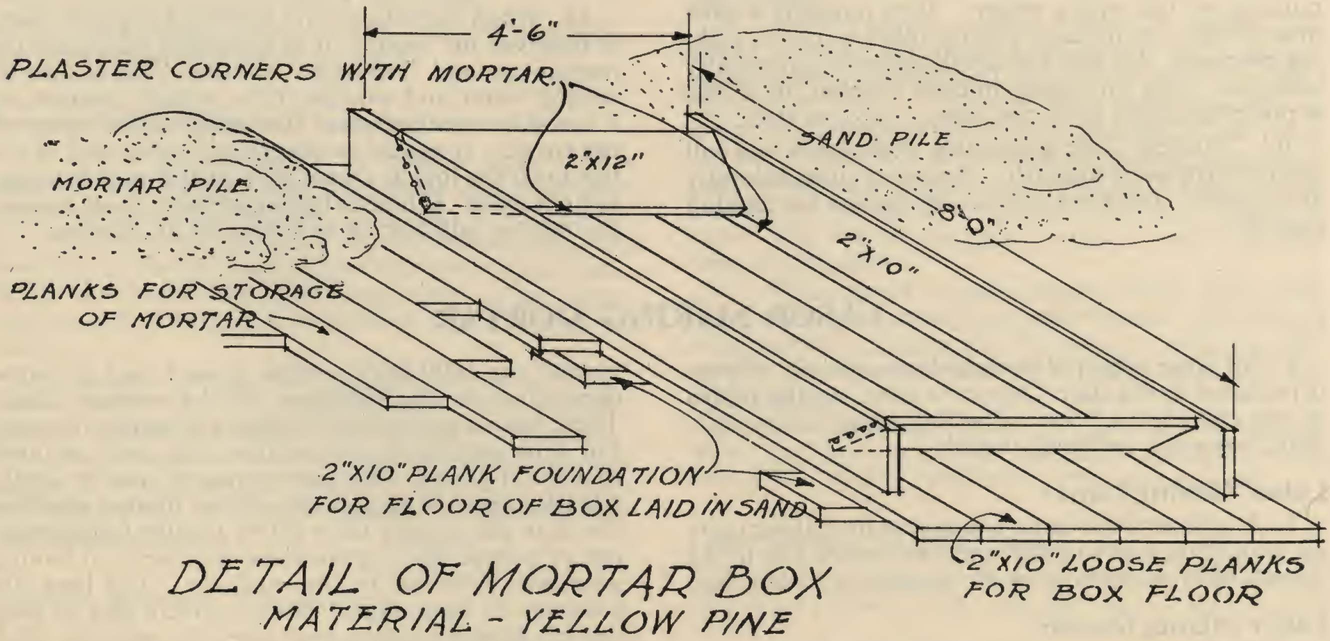
Barrels and Tools:

7. A hose connected with the water supply, a mortar hoe, and a shovel are necessary. Where lump lime is to be slaked, even if there is a hose which will throw a good stream, it is well to have a barrel of water and a pail in case the lime begins to burn while slaking. Where there is no city water supply two or three barrels should be provided. If dry mortar colors are used, in another barrel may be kept a supply soaked in water.

8. The cost of mixing mortar can frequently be reduced and a more uniform mixture obtained by the use of a small power driven mortar mixing machine.

Locating Mortar Bed:

9. The box and platform should be several feet from the building to avoid splashing the wall. They should not be located at such a distance that the mortar will have to be carried very far. Where an inclined way is used to wheel or carry materials to any story the box should be somewhere near the bottom of the incline, or near the hoist if this is used. The sandpile is placed near the box and so located that a team can drive up and deposit sand.



DETAIL OF MORTAR BOX
MATERIAL - YELLOW PINE

BONDS AND JOINTS
BONDS

Bond; Definition:

1. The full strength of brickwork cannot be attained without good bond. The word bond means "to bind." Bond is the method of arranging the brick units so that by their overlapping the entire wall is thoroughly tied together throughout its length and breadth and will act as a unit in resisting stresses.

2. "Stretchers" or brick laid lengthwise of the wall, develop its longitudinal strength.

3. "Headers" or brick laid across the wall, develop its transverse strength.

4. Every type of brick wall is enormously strong and will carry great loads when properly built; so that for structures not carrying heavy loads, the relative strength of the various types of bond need not be considered.

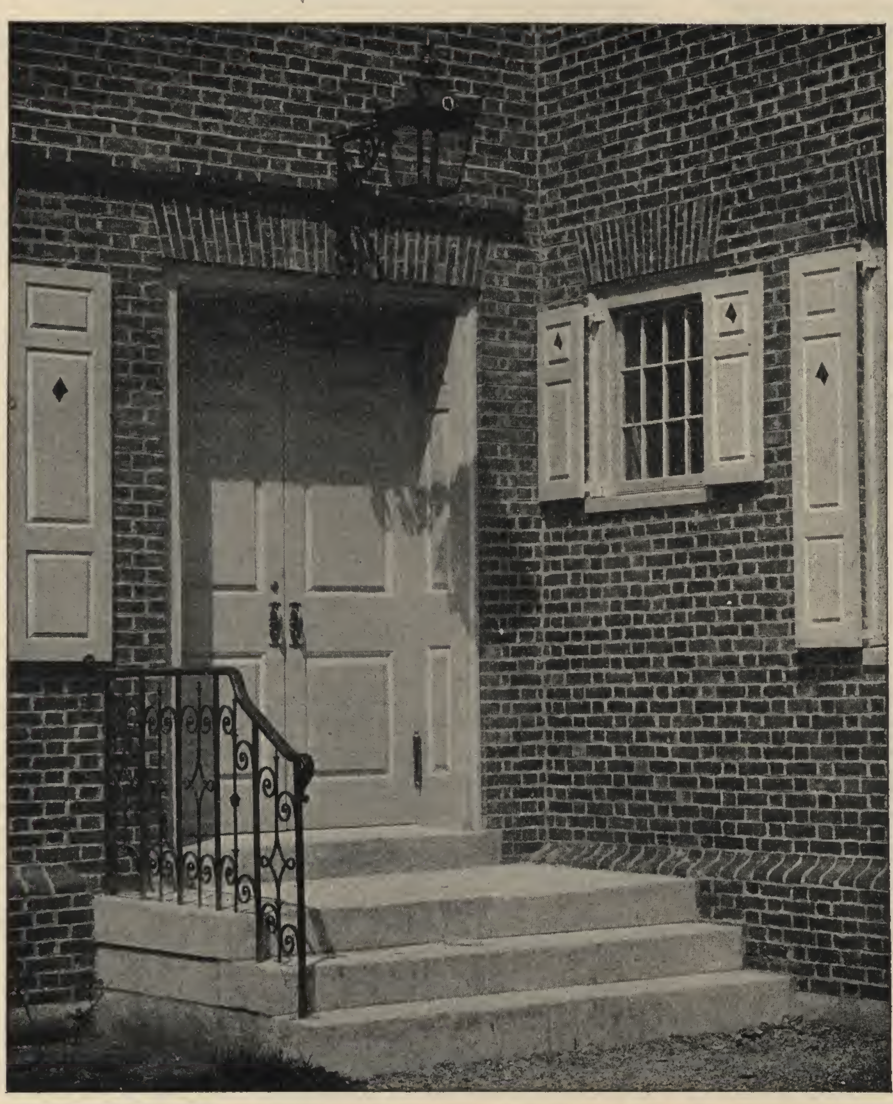


Figure 1. Detail of Harvard Freshman Dormitories, Cambridge, Mass. Flemish bond with concave joints (Diagram G page 71). Note the charming effect of the contrast between the light mortar and darker brick. Note also special plinth bricks. "Jack" arches formed as described in pars. 76-77, page 81.

Headers in Solid Walls:

5. The brick walls in an ordinary building are never called upon to support more than a small part of the load they will safely bear. If the foundation settles unevenly, however, some stress may be caused in the direction of the length of the wall; although the brick wall is adapted to adjust itself to slight movements such as this without cracking or other damage, by reason of its small units and numerous joints.

6. It would appear logical, therefore, to build a solid wall mostly of stretchers, with just enough headers to tie it together thoroughly and securely.

7. In a solid wall built entirely of common brick, all the headers which appear on the face of the wall are real or "through" headers. Where face brick are used, it is most economical to make all headers not required for ties, bat headers, so that the face brick will go further. Face brick should be cut at the middle so that each half of the brick can be used for this purpose and waste avoided.

8. The number of through header courses is generally defined by building ordinances. Placing a header course at every sixth course (five non-header courses between) is a safe rule, however, except where the backing brick is laid on a full bed of mortar but with dry vertical joints, in which case through headers should be placed every fifth course.

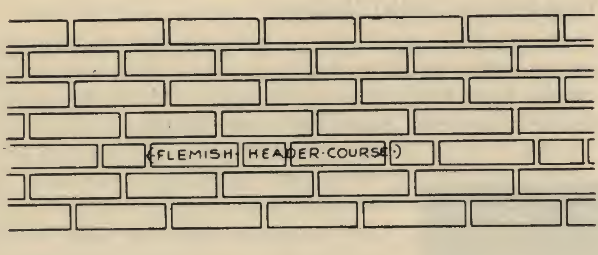
9. Header courses may consist of a full course of headers, or of headers and stretchers placed alternately (Flemish header course.)

Small Units Make Stronger Wall:

10. Because of its numerous units, brick masonry possesses a considerable degree of elasticity, enabling it to adapt itself, with least possibility of cracking or damage, to slight, irregular movements in the bearing soil which may be expected to occur even in the first few years of the centuries a brick structure lasts.

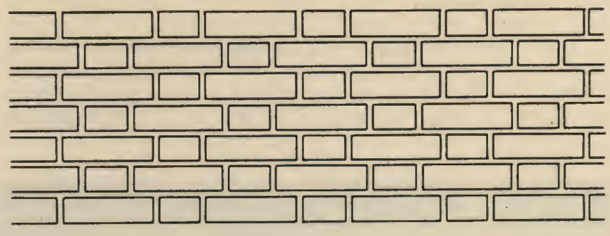
Appearance of Bonds:

11. In exposed work, the bond fulfills another purpose, the mortar joints forming attractive geometrical patterns on the surface of the wall, this being an important factor in the beauty of brickwork. Brick units laid flat or on edge have the proper

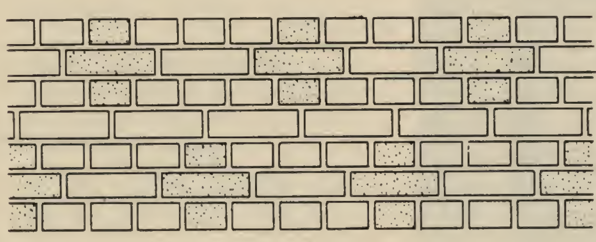


·COMMON·BOND·

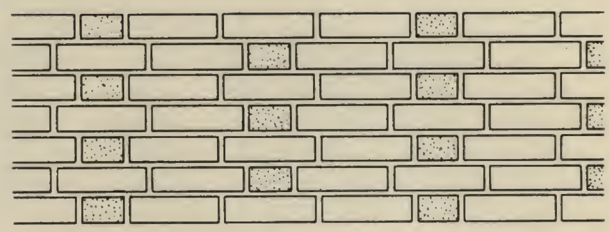
·NOTE–THE·ABOVE·FLEMISH·HEADER·COURSE·IS·USED·IN·
·RESIDENCES·AND·THE·MORE·PARTICULAR·CLASS·OF·WORK·
·A·CONTINUOUS·HEADER·COURSE·EVERY·SIXTH·OR·SEVENTH·
·COURSE·IS·USED·WHERE·APPEARANCE·IS·LESS·IMPORTANT·



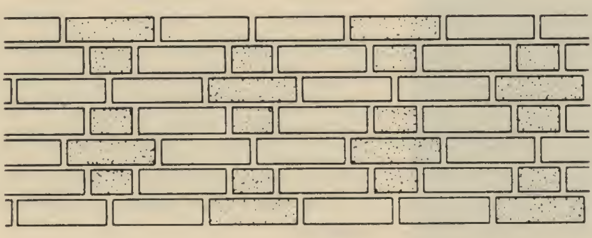
·FLEMISH·BOND·



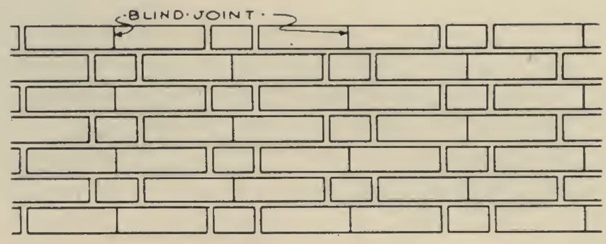
·ONE·OF·MANY·METHODS·OF·EMPHASIZING·
·PATTERN·IN·ENGLISH·CROSS·BOND·



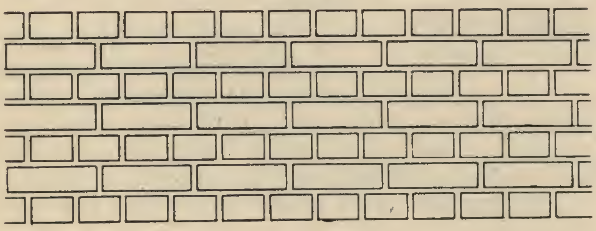
·GARDEN·WALL·BOND·



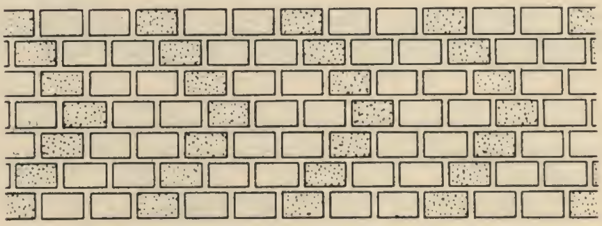
·FLEMISH·CROSS·BOND·



·DOUBLE·STRETCHER·FLEMISH·BOND·



·ENGLISH·BOND·



·RUNNING·HEADER·BOND·

BONDS·USED·IN·BRICKWORK·

·PLATE·NO·1·

relation of height to length, which gives an appearance of stability and harmonious proportion, and the units are of such size that any architectural composition may be designed in scale of these units or patterns to suit. The jointing should be such that the brick units can be clearly seen, even at a distance. This is of great importance in producing successful brickwork (par. 17, page 70).

Selection of Bond:

12. Cost and appearance should be chiefly considered except for extremely heavy loads. For exposed work the most suitable bond will be determined by the architectural design. For unexposed work and exposed low cost work, common bond is generally employed, costing least because easily and quickly laid and in practice being probably the strongest of the bonds. Many charming buildings are, however, faced with brick in common bond. For piers or walls carrying heavy loads lay the bricks on edge.

13. Flemish bond is most practical for Ideal all-rolok walls where such walls are exposed. Any bond may be employed for facing Ideal rolok-bak walls. Economy walls are naturally built in common bond, with headers here and there for tying in the pilasters and for corbelling at floor and roof lines.

14. The same procedure should be followed for selecting bond as for selecting exposed brick. (Par. 19, page 58.)

Types of Bond:

15. There are three basic types of bond and a multitude of variations of each: Running Bond, Flemish Bond and English Bond.

Running or Stretcher Bond:

16. The surface of the wall is made up of stretchers which break joint at the centre. (Fig. 3; see also Fig. 6, page 71.) At the corner a header appears at each alternate course. Because of lack of headers the bond is weak transversely. Only full headers have sufficient rigidity and bonding area to distribute the load so that the outer course carries its normal proportion. In a solid wall twelve or more inches thick, sometimes the brick in the centre is laid diagonally every few courses, the triangular portion of the brick projecting beyond the backing, forming a tie sufficient only to attach the face brick to the backing (clipped bond, Fig. 2.) Metal ties are sometimes used, (Fig. 3) but with each of these methods only the backing can be calculated to support the load. Metal ties are unsatisfactory also because they are liable to rust and their use is not recommended.

CLIPPED BOND

Figure 2.

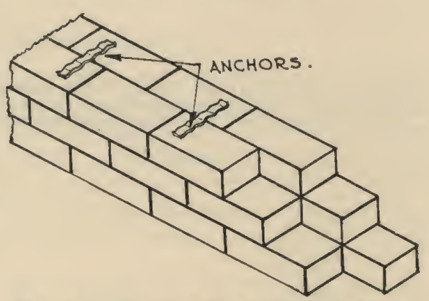


Figure 3. Running bond with metal ties.

17. Double headers are sometimes used with a buttered joint between at every sixth or seventh course, the pair of headers appearing as a stretcher. This forms a thoroughly good bond, in reality a form of common bond.

Common Bond:

18. A variety of running bond but with every fifth, sixth or seventh course a header course, either "full" or "Flemish," the former being all headers, the latter with headers and stretchers alternately. More bricks are laid in this bond than several times all the other bonds combined. It is used for exposed and unexposed work and is the lowest in cost for solid walls or for facing Ideal rolok-bak walls. This bond is shown on plates 2 and 3.

19. A "three quarter" brick starts each header course at the corner of the wall; brick in other courses not requiring to be cut at the corners to make them break joint. In a twelve inch wall two header courses are used, one on each side of the wall in adjoining courses, overlapping in the centre of the wall. (Fig. 4.)

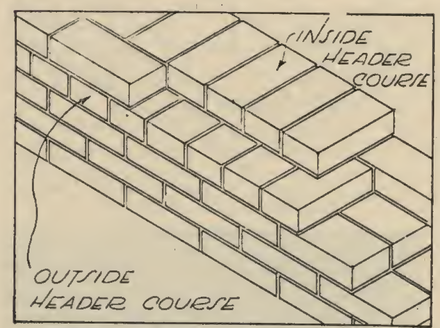


Figure 4. Header courses in 12" wall, common bond.

20. For exposed work the joints are kept perpendicular, but for unexposed work the brick does not require such careful placing. The end of a stretcher can be placed anywhere within the centre 4" of the stretcher below and still produce a good bond. (Fig. 5.) This flexibility makes for rapid work.

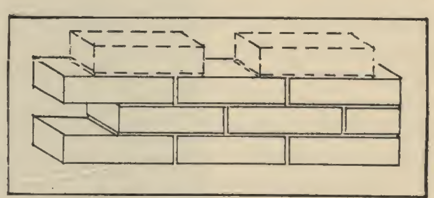


Figure 5.

Corners in Flemish and English Bond:

21. Before describing the above bonds, attention is called to two distinct methods of starting corners with each of the above types of bond. To correctly locate the vertical joints it is necessary to introduce at the corner a unit half a header in width. In English brickwork a header split in half or "closer" is used, (lower illustration, Fig. 6, also Fig. 5, page 71), but in Dutch brickwork the closer is eliminated and the same effect obtained by using a three quarter brick in the stretcher courses. (Upper illustration, Fig. 6.)

22. If a "closer" is used, never place it directly at the corner. Start with a full header, followed by the closer.

Flemish Bond:

23. This bond is a great favorite among builders, being easy to lay and producing a very artistic and pleasing wall surface. It costs more to lay than common bond, because of the greater care required in the workmanship, but is more attractive in appearance. (Fig. 6, also Fig. 1, page 65, and Figs. 2, 3 and 5, pages 70-71.)

Double Stretcher Flemish Bond—Garden Wall Bond:

24. A variety of Flemish, with two stretchers followed by a header in each course, the header centered on the pair of stretchers. (Fig. 7.) In double stretcher Flemish bond the joint between the pair of headers is a blind or invisible joint, this constituting the sole difference between double stretcher Flemish and double stretcher garden wall bond; in which latter all the joints have the usual appearance. Ordinary garden wall bond has three stretchers between headers, but may have from two to five stretchers between headers.

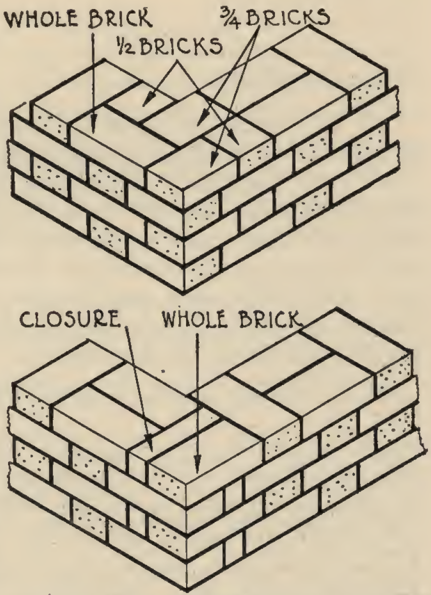


Figure 6. (Upper) Dutch Corner. (Lower) English Corner. (Par. 21).

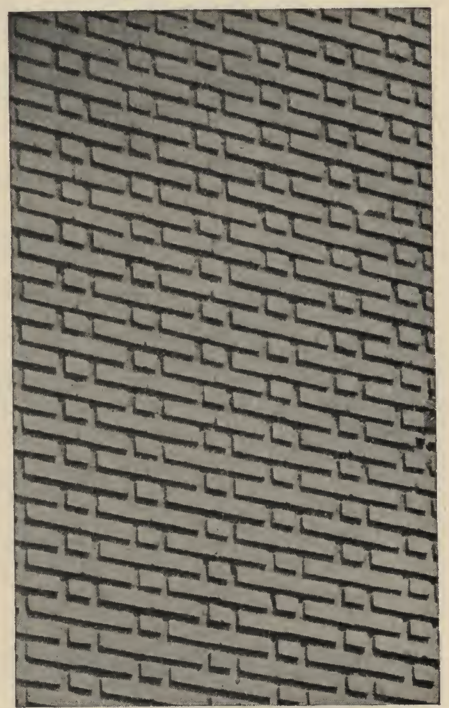


Figure 7. Double Flemish bond, stripped joints. (See also Fig. 38, page 48.)

English Bond:

25. Composed of alternate courses of headers and stretchers, headers centering on stretchers or joints between them. Joints between stretchers are vertically over each other in all stretcher courses. Note alternate methods of forming corners. At the right of the external corner closers are used, on the left three-quarter brick avoiding closers. (Fig. 9).

English Cross and Dutch Cross Bond:

26. Similar to English bond, but an interlacing pattern of Greek crosses is produced by breaking

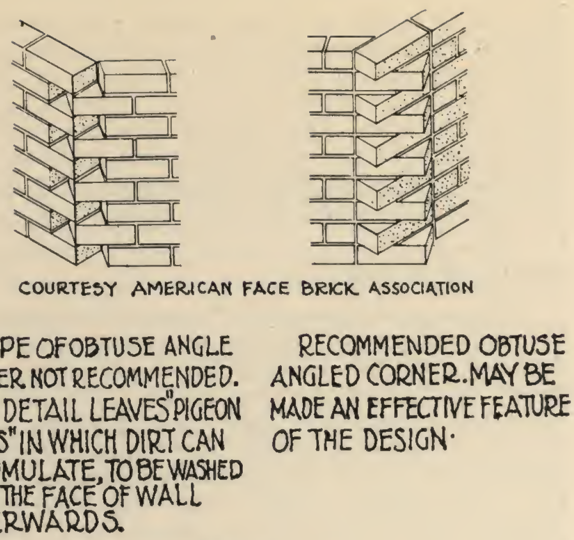


Figure 8.

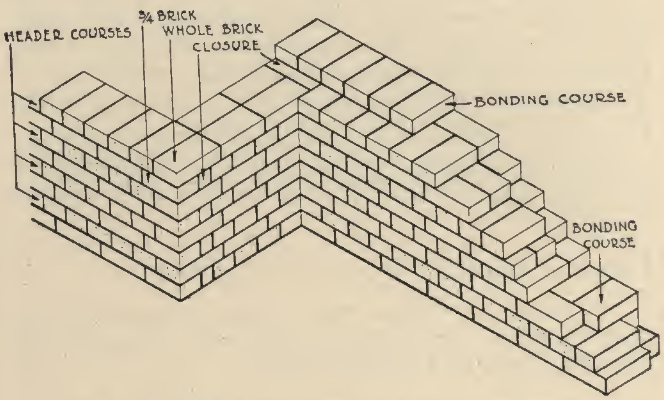


Figure 9. English bond with Dutch corner (on left) and English corner (on right).

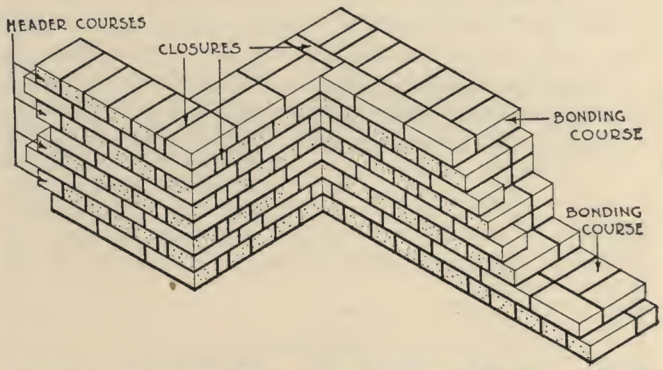


Figure 10. English Cross bond. Corners started with closers. Dutch Cross bond or Dutch bond is exactly the same except that the corners are started with ¾ brick instead of closers, as shown in Fig. 12.

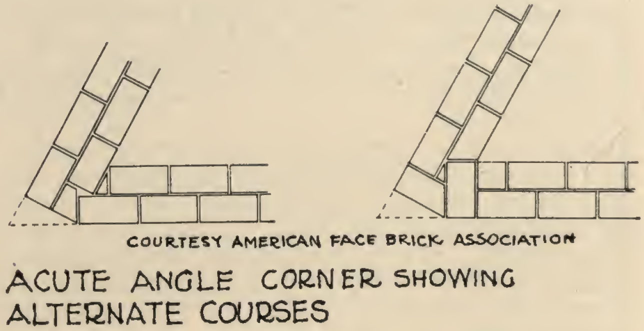


Figure 11.

joints in the stretcher courses; ends of stretchers in each stretcher course centering on stretchers in courses above and below. (Fig. 10.) The note under the illustration explains the difference between English cross bond and Dutch cross or Dutch bond.

Bond in Backing:

27. Whatever bond is used on the face, unexposed backing is always laid in common bond.

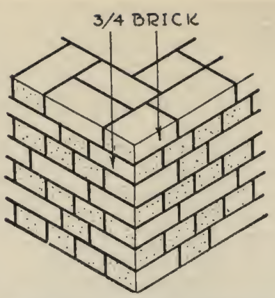


Figure 12. Dutch cross bond or Dutch bond, corner started without closers.

Brick Patterns:

28. Large scale patterns formed by the geometrical arrangement of various colored bricks and joints are very effective if the designs are appropriate and scale with the elevation. For large wall surfaces such patterns may be used to splendid advantage but for the ordinary residence or small building they should be employed with caution to scale with the building. More bricklayers' time is required to form patterns than to lay the ordinary bonds.

JOINTS

Shoved Joints:

1. On a bed of mortar a little thicker than the finished joint will be, the brick is pressed downwards and sideways, the soft mortar rising between and filling the vertical joints. Used for solid walls and piers and the outside 4″ thickness of Ideal rolok-bak walls.

Grouted Joints:

2. The brick are bedded on a full bed of mortar, vertical joints being filled with grout composed of similar materials with more water added.

3. To grout a wall quickly and conveniently, provide each bricklayer with a bucket of water and a long handled dipper. After placing a course of brick (laid the thickness of a joint apart) and taking the dipper with his left hand, trowel with his right, he picks up a trowel of mortar and a dipper of water with one motion. Spreading the mortar with one hand, he adds water from the dipper with the other, meanwhile working the mixture between the joints with his trowel until they are completely filled.

4. Grout is used in solid walls 12″ or more thick, the outer and inner courses being "shoved" with mortar of ordinary stiffness to retain the grout. Grouted brickwork is less expensive than shoved brick work and accomplishes the same purpose; but should not be employed where the face is to be left exposed on account of occasional trickling.

Filled Joints; Where Required:

5. The strongest and most fire-resistive brickwork is laid solid with all joints full of mortar and for fire, party and division walls, and for construction in which piers or walls carry heavy loads and resist considerable stresses, all joints should be filled. Chimneys should have all joints especially well filled, including against the flue linings to insure a good draft.

6. Basement walls required to resist considerable dampness should have all joints filled.

7. In all walls exposed to the weather, the outside 4″ course should be "shoved".

Specifications Should Not Always Require "All Joints Filled":

8. It is a mistake to specify "all joints filled with mortar" for all work. It is a difficult matter to get a mason to shove all the brick he lays, for a man's hand will be raw and tender after shoving brick all day. Theodore F. Laist, formerly Senior Architect of the Division of Valuation, Interstate Commerce Commission, states that requiring all brick to be shoved "generally adds unnecessarily to the expense. . . . . In some respects not filling the joints is an advantage since it creates an air space in the walls."*

Open Joints, Where Allowed:

9. For solid construction above grade in common bond in a residence, a wall can be constructed by laying all the brick on a full bed of mortar, with joints in the outside course exposed to the weather shoved full, the brick in the backing (or in the full thickness of an interior partition) touching end to end and the vertical space between each 4″ thickness left open. Every fifth course should be a header course with full joints and the mortar mixed softer than usual.

10. For walls built this way with other bonds, the exterior eight inch thickness should have as many of the vertical joints running parallel with the length of the wall left open as is practicable. If thicker than 8″, lay the remaining thickness as described above for exterior walls above grade.

11. In the walls described, the partial interruption in the contact of material through the wall is considered to make the latter more weather resistive. Such a wall is also cheaper to lay, appears to dry out more quickly and is amply strong for ordinary loads.

12. Basement walls in fairly dry soils may be laid with the outer joints shoved full, the brick in the remaining thickness laid on a full course with brick touching end to end and the vertical space between each 4″ course filled with mortar.

Dry Joints:

13. Sometimes in low cost work every sixth course on the interior face of a wall is laid directly on the brick below, omitting the bed of mortar. "Dry" horizontal joints provide secure nailing for grounds, frames, etc., but weaken the wall and are not recommended.

*American Contractor.

Joints in Ideal Walls:

14. The facing and backing in all Ideal walls should have full joints. The end joints of brick on edge are filled by "buttering" the bricks before they are placed.

Exposed Joints:

15. The mortar joint constitutes a considerable proportion of the area of the finished wall and hence should be considered as to (a) width, (b) color, (c) section, (d) texture.

16. With a standard brick two headers require a ½″ joint to coincide with the length of a stretcher. In forming bonds and patterns the ½″ joint is thus most practical. Joints ⅝″ and ¾″ wide are used extensively and are very effective, the difference between the unit length of a stretcher and two headers plus a joint being taken up by slightly varying the width of the vertical joints. Joints 1″ and even wider have been used. A joint of ¾″ and over slows down the work, a thick bed of soft mortar under each brick being more difficult to manipulate. Special mortar should be used for wide joints. (Par. 4, page 61.)

Figure 1. Struck joint, diagram A, common bond.

Figure 2. Weathered joint, diagram B., Flemish bond.

Color of Joints:

17. The richness of tone in the individual brick may be brought out and displayed to the best advantage by the proper selection of contrasting effects, which may or may not require the use of color in the joints. No matter what bricks are used, the effect may be spoiled and the wall have a "muddy" appearance if the color or tone of the joints is too near that of the bricks. The joints should be plainly visible, even at a distance. The importance of this cannot be over stated. Note the effect of contrasting mortar and joints in Fig. 1, page 65, and in the illustrations on these pages.

18. Although the slight graduations in the shading of the brick add greatly to the beauty and interest of the finished wall, the color of the mortar joint must be kept even to produce the best effect. Very often natural uncolored mortar will produce excellent

Figure 3. Flush joint, diagram C, Flemish bond.

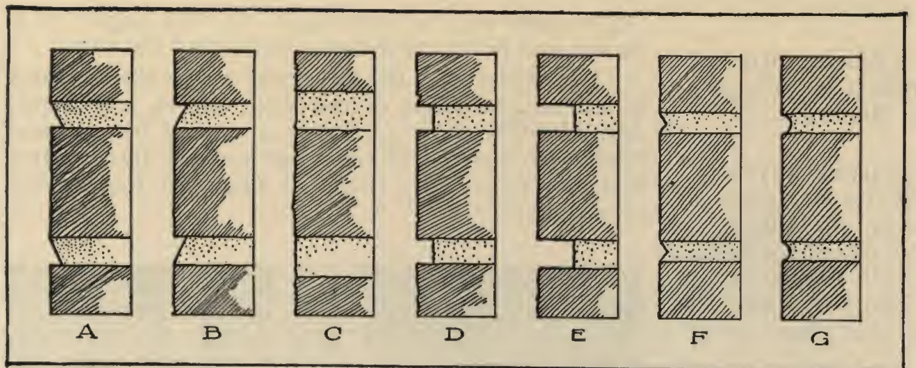


Figure 4. A, struck joint. B, weathered joint. C, flush or plain cut joint. D, raked joint E, stripped joint. F, "V" joint. G, concave joint.

results, particularly with a red or darker brick. Strong sunlight will cause any artificial mortar color to fade somewhat.

Section and Texture of Joints:

19. For exposed work the joints are made flush or recessed. With the former, the individual bricks are visible according to the contrast in color and texture between brick and joint. With the latter, the brick outlines are also marked by their shadows.

20. Some designers feel that the texture of the mortar joint should resemble that of the brick, but it is unsafe to lay down hard and fast rules, for charming effects are often produced by a contrast in the texture of brick and joint.

21. A steel jointer or trowel produces a smooth texture, a wood surface being generally used for a rough texture; coarse sand or even fine gravel in the mix, if the joint is wide enough, also assisting to form a rough surface.

Plain Cut Joints:

22. Used for concealed surfaces and for joints in fire and party walls. Plain cut joints may be used on a basement wall to receive cement damp proofing. Formed by simply cutting off excess mortar with the edge of the trowel.

Struck Joints:

23. Cheapest and most easily formed joint for exterior surfaces. (A, Fig. 4, also Fig. 1.) When well done makes a neat wall. Sometimes objection is made that this joint is not as weather resistive as the weathered joint; but raked joints, which expose much more of the upper surface of the brick, have proved successful and this objection would seem more theoretical than practical.

24. This joint is the most widely used of all for exterior exposed work and for the inside exposed surface of basement walls and other unplastered brick surfaces. It should be used on a basement wall on which asphalt or similar damp proofing is to be mopped.

Figure 5. Concave joint, diagram G. Flemish bond, closers at corner. Larger surface with similar joints shown in Fig. 1, page 65.

25. It is formed as a plain cut joint and finished with the trowel as the mortar becomes stiffer.

Weathered Joints:

26. Similar to a struck joint but formed from above with a little more difficulty and costing slightly more. Each course of brick throws a slight shadow. It is difficult to preserve exactly the same slope on the face of the joint. (B, Fig. 4, also Fig. 2.)

Figure 6. Stripped joint, diagram E, Running bond.

Flush Joints:

27. Almost always finished with a rough texture. When used with rough textured brick it is difficult to keep the mortar from the face of the brick. (C. Fig. 4, also Fig. 3.)

28. Formed by cutting off mortar squeezed beyond the face of the wall. The joint must not be manipulated afterwards with the trowel or the cement may be drawn to the surface and the rough texture spoiled. If further treatment is needed the surface may be gently tapped with the end only of a piece of wood having an extremely rough end grain.

Raked Joints:

29. The joint is first plain cut and afterwards raked out to the depth desired, a steel jointer being employed to obtain a smooth texture, a wood stick for a rough texture. (D. Fig. 4.) Corners should be formed square and all excess mortar removed to produce the neatest effect. A cheaper method is to rake the joint quickly and roughly with a stick as the wall is built, brooming out the excess mortar the following day, no attempt being made to produce square corners. This method is often followed by speculative builders. It should not be attempted with rough textured brick.

30. Ideal all-rolok walls may be constructed with raked joints, if the rake is not cut too deeply. A brick on edge has 2¼ in. bearing surface. A ½ in. rake, therefore, will leave 1¾ in. of bearing surface.

Stripped Joints:

31. Produces the neatest and cleanest raked joint and is specially useful with rough textured brick, as it keeps the mortar from the face of the wall. (E. Fig. 4, also Fig. 6, and Fig. 7, on this page.) It is slower and more expensive than raking the joint.

32. A wood strip the thickness of the mortar joint is laid at the front of the wall, set in any depth desired. The bed of mortar is placed behind and flush with the top of the strip and the next course laid, the strip being removed when the mortar has set sufficiently.

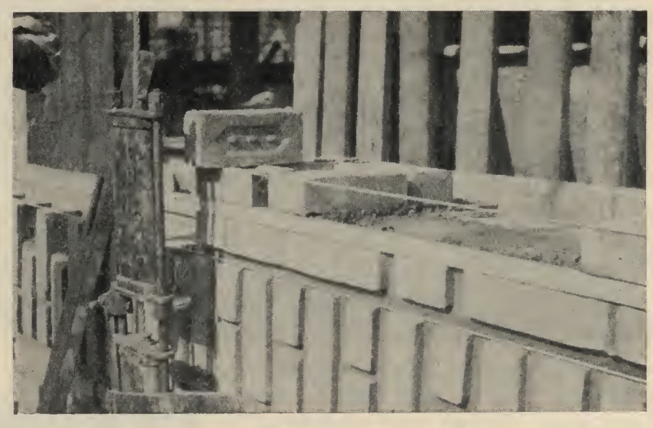
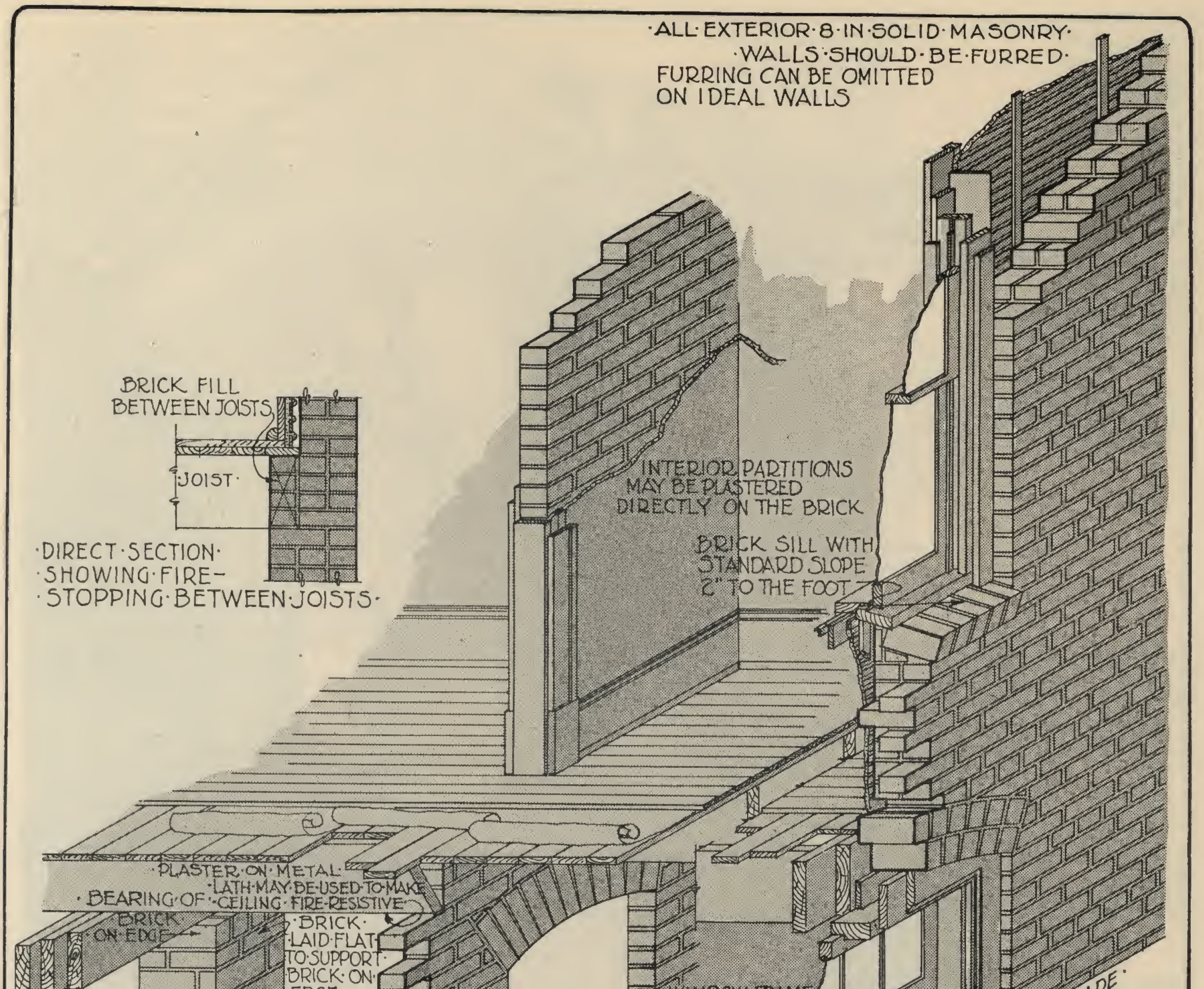


Figure 7. Forming stripped joint. Horizontal course in Double Flemish bond. Note "blind joint" between pairs of stretchers

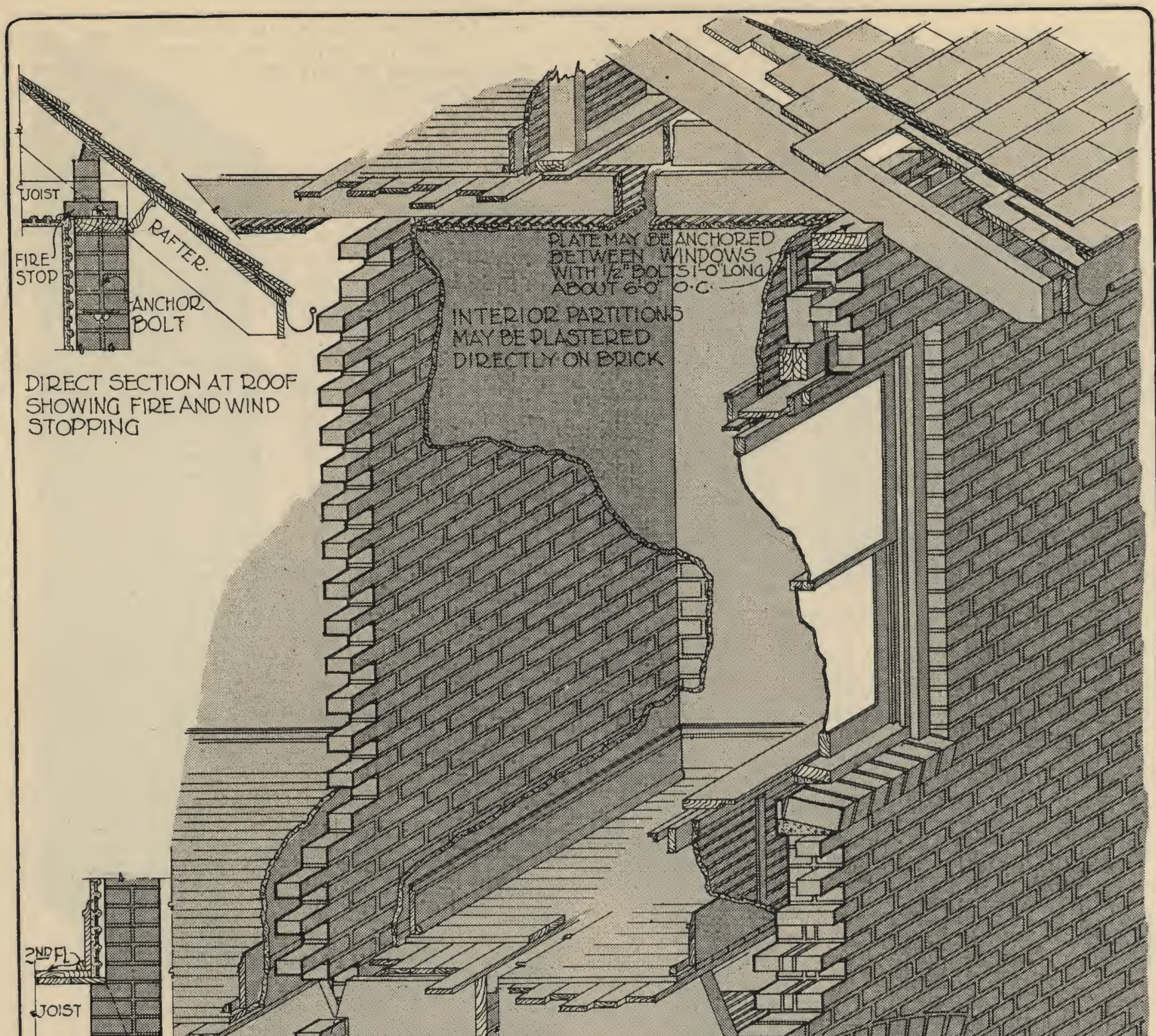
V Joints and Concave Joints:

33. Are comparatively inexpensive to form and are weather resistive. (F. and G. Fig. 4, also Fig. 5.) Both are best formed with special tools made for the purpose. A "V" joint may be roughly formed, however, with a square edged board held at an angle and rubbed along the joint and a concave joint may be similarly formed with a board having a rounded edge, or a bent iron rod.

Many of the diagrams and photographs in the chapters on Bonds and Joints are reproduced by the courtesy of the American Face Brick Association and the Builder's Journal

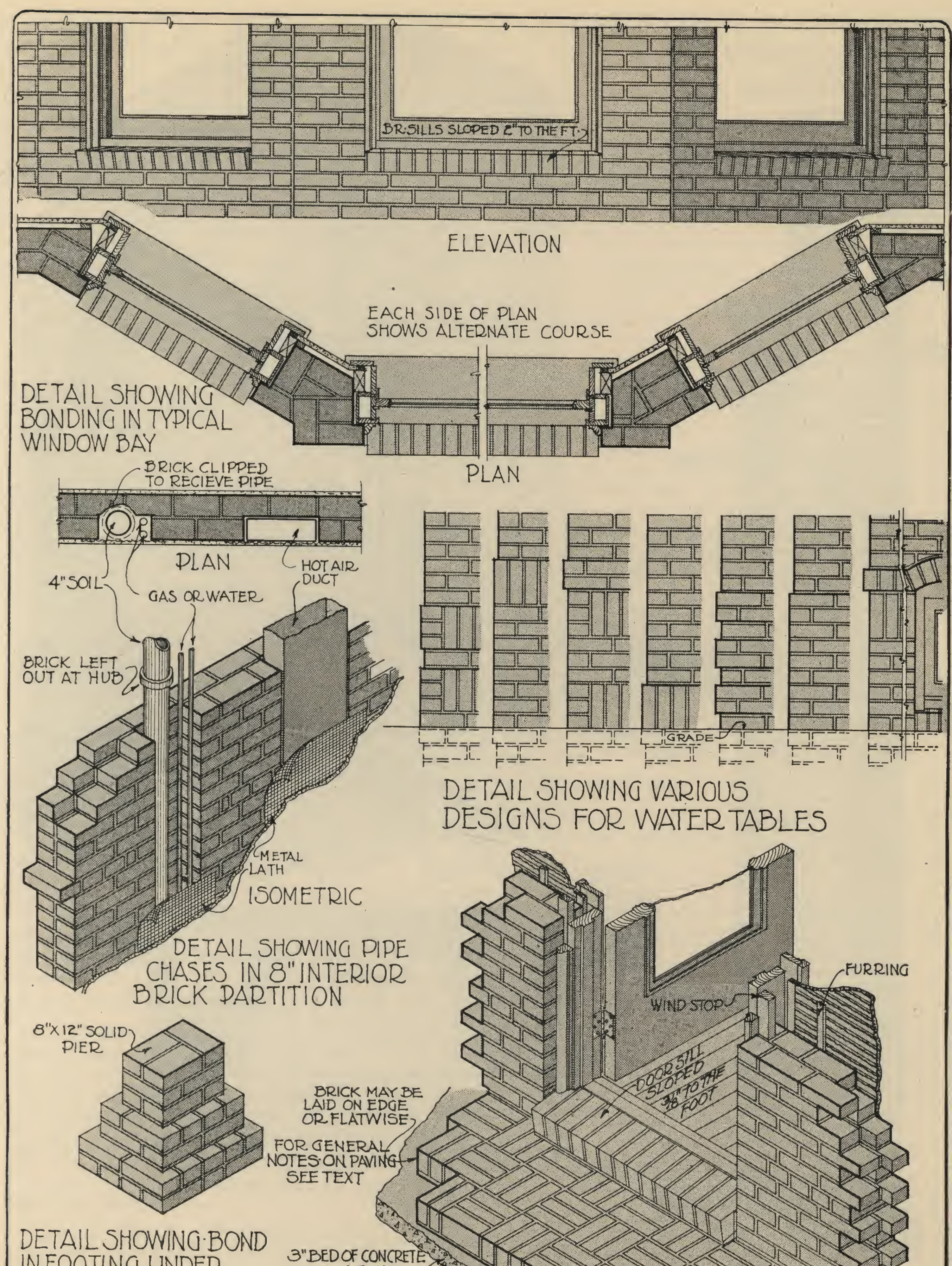


·ISOMETRIC·SECTION·OF·A·SOLID·BRICK·HOUSE·
·PLATE·NO·2· ·SHOWING·CONSTRUCTION·OF·BASEMENT·AND·FIRST·FLOOR·

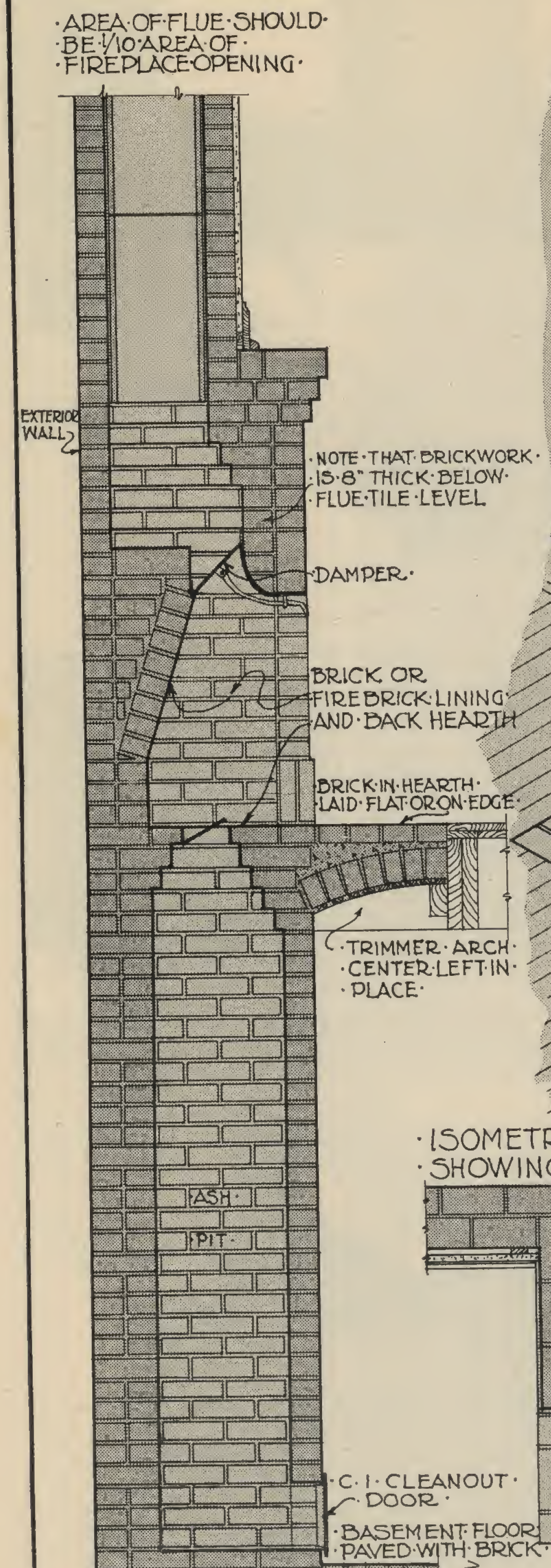


·ISOMETRIC·SECTION·SHOWING·CONSTRUCTION·OF·A·SOLID·BRICK·HOUSE·UPPER·PART·OF·FIRST·FLOOR·SECOND·FLOOR·AND·ROOF·

·PLATE·NO·3·


BR·SILLS SLOPED 2" TO THE FT·
ELEVATION
EACH SIDE OF PLAN SHOWS ALTERNATE COURSE
DETAIL SHOWING BONDING IN TYPICAL WINDOW BAY
PLAN
BRICK CLIPPED TO RECIEVE PIPE
PLAN
HOT AIR DUCT
4" SOIL
GAS OR WATER
BRICK LEFT OUT AT HUB
METAL LATH
ISOMETRIC
DETAIL SHOWING PIPE CHASES IN 8" INTERIOR BRICK PARTITION
GRADE
DETAIL SHOWING VARIOUS DESIGNS FOR WATER TABLES
FURRING
WIND STOP
DOOR SILL SLOPED 3/8" TO THE FOOT
BRICK MAY BE LAID ON EDGE OR FLATWISE
FOR GENERAL NOTES ON PAVING SEE TEXT
3" BED OF CONCRETE 1:8 MIX
8"X12" SOLID PIER
DETAIL SHOWING BOND IN FOOTING UNDER TYPICAL 8"X12" PIER
DETAIL OF EXTERIOR DOOR AND PORCH FLOOR PAVED WITH BRICK

·PLATE·NO·4·



·SECTION·THRU·
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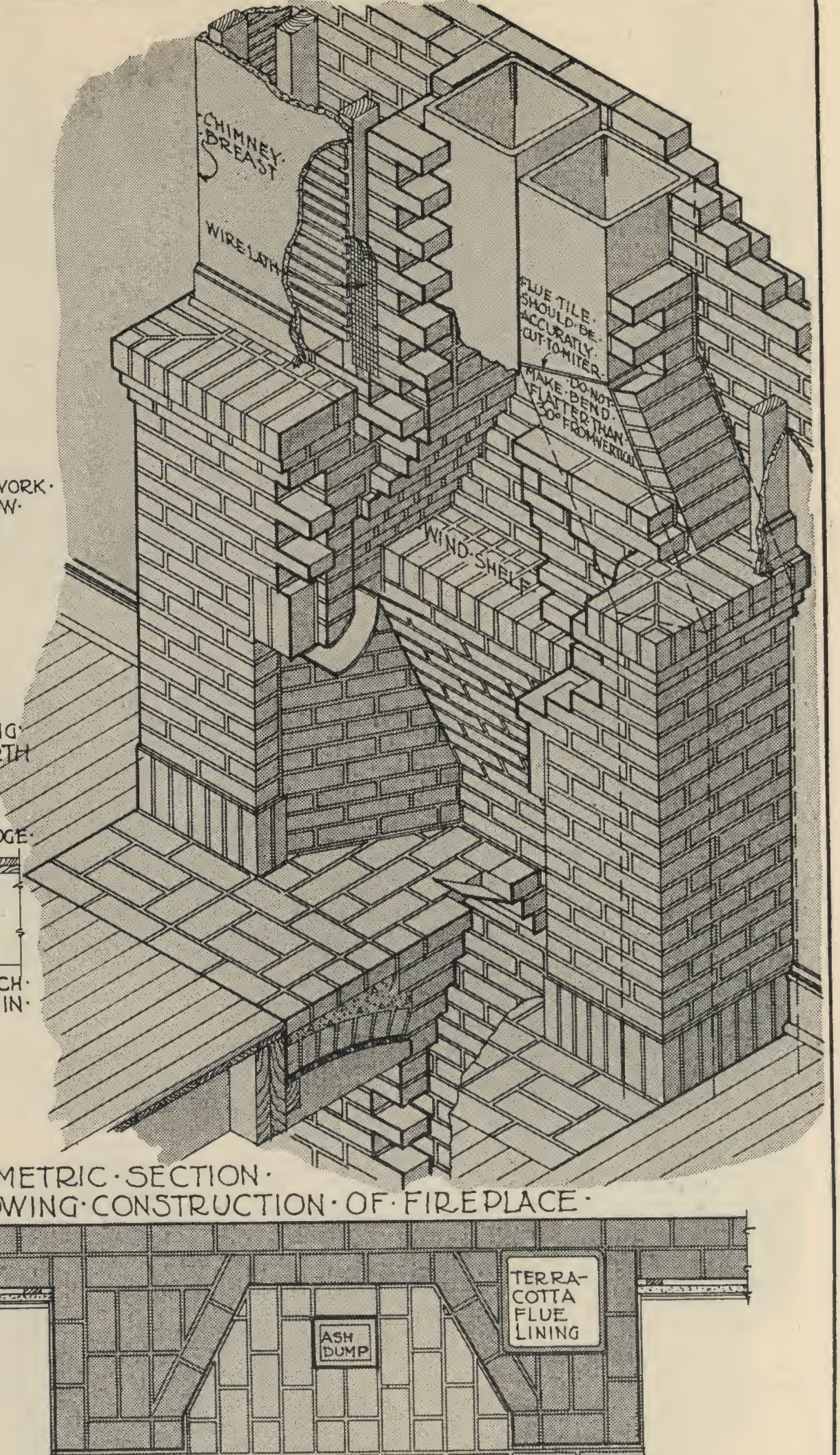

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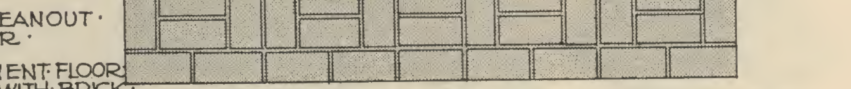


·PLAN·OF·FIREPLACE·AND·HEARTH·

·DETAILS·OF·TYPICAL·BRICK· ·FIREPLACE·AND·HEARTH·

·PLATE·NO·5·

BRICK RESIDENCE CONSTRUCTION

General:

1. Many points dealing with residence construction have already been covered under various heads in the preceding portion of this book.

Brick Veneer on Frame:

2. In many cases it is possible to materially improve an old frame property by veneering it with a shell of 4″ of brickwork. The brickwork undoubtedly adds to the life of the house and "paints" it with an enduring surface which does not have to be renewed.

3. It is not the best practice, however, to construct new buildings of brick veneer on frame. One of the great advantages of brick construction is the permanence and fire resistiveness of its walls, advantages not so fully shared by brick veneer. In a wall of first-class construction the entire wall acts as a unit in bearing loads and resisting stresses.

4. Some architects and builders are evidently not aware that brick veneer costs more than solid, Ideal, and especially Economy brickwork in any part of the country.

5. The building public should especially be on its guard against accepting stucco finish on frame construction as being in any way comparable with any form of honest masonry.

Water Table and String or Belt Courses:

6. The treatment of the brickwork above grade will, of course, depend on the architectural design. The entire wall above the grade may be laid without any special treatment other than the proper proportioning and placing of the windows, the beauty and value of an unbroken surface of brickwork being taken advantage of to the full.

7. Sometimes the proportion and type of the building or the size and disposition of the window openings will make desirable the introduction of horizontal courses to divide the wall surface into two or more bands.

8. Brickwork is often started at the grade line with a simple soldier course, or course of brick on end, or the whole height from grade to first floor line may be specially treated as a water table or plinth. Various types of watertable treatment are illustrated in Plate 4. Suggested types of string course are shown in Fig. 1.

Dividing Work:

9. Always divide off the wall so that each bricklayer will have about the same amount of work to do. This will enable the contractor to pick out the best men. On a wall with few openings bricklayers are placed about 6 feet apart.

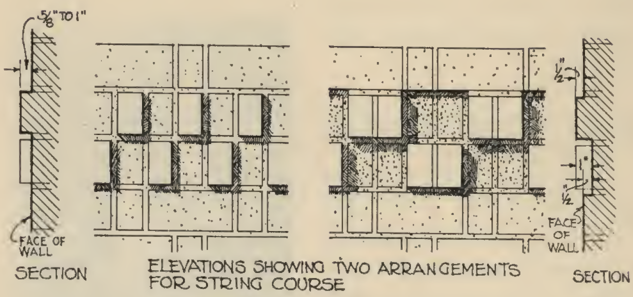


Figure 1. String courses for either solid or Ideal walls.

Wet the Brick Before Laying:

10. It is most important that all brick except impervious brick be wet before being laid, except in freezing weather. The hotter and drier the weather, the more water should be used. If the bricks are not wet, they will absorb the moisture from the mortar, which will interfere with its setting and adhesion to the bricks. On the other hand do not soak the bricks, as they can be made so wet that they will slide on a bed of mortar and this may also thin the mortar so it will run down the face of the wall, making good work difficult.

Handling Brick:

11. Do not allow the brick tenders to throw down the brick on the scaffold so that they scatter or even chip. Care on the part of tenders will save the more valuable time of the bricklayers.

Keep Scaffold Clean:

12. The bricklayer's working space on the scaffold can be kept clean and tidy just as well as not, and by ensuring a good foothold will add to the efficiency of the masons.

13. Every bat or broken brick can and should be used in the wall as the work goes along. No brick should be wasted.

Protect Work at Night:

14. The walls should be protected every night by being covered with boards or other substantial protection to keep off the rain and weather. Boards should have bricks piled on them loosely to prevent the wind blowing them off.

Building the Wall:

15. The bricklayers build the walls from the inside, pointing the face as they go. The most experienced bricklayers are placed at the corners to run up the leads and raise the line. Leads consist of a few courses of brick run up at the corners to which the "trig" and line are attached. The line is generally raised course by course.

Leave Openings and Chases:

16. The location of chimneys, openings and chases shown on the plans or necessary should be carefully noted and all such items taken care of as the wall goes up.

Build in Nailing Blocks and Grounds:

17. When building Ideal walls, build in nailing blocks for the carpenters to attach base and trim. These blocks can be small pieces of 2″ x 4″.

18. For attaching furring strips to solid walls build in plasterers lath in the joints about every seventh course, well backed with mortar and slightly projecting; always break joints of lath.

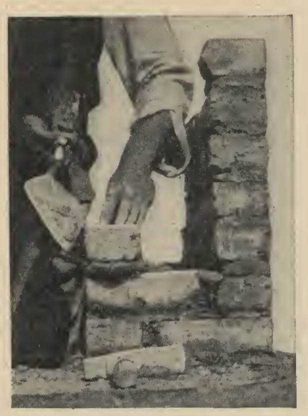


Figure 2. Laying backing, solid construction.

Footings:

19. A residence foundation wall 12 in. thick built upon firm ground will not require a footing in the majority of cases, except where concentrated loads occur. Where a footing is deemed necessary it may either be composed of concrete poured into a trench or built expeditiously of hard burned brick in cement mortar. The footing for a 4″ interior partition may be 8″ wide, consisting of a header course on edge.

20. Projections are formed by stepping off each course or every other course about 2″, the projections being formed of a continuous course of headers. Projections should be equal on both sides of the wall. It is recommended that projecting courses be formed of brick on edge, these being capable of resisting a greater transverse strain than flat courses.

21. The excavation should be carefully levelled and the first course laid on cement mortar spread upon the ground.

22. Footings or walls without footings must always be taken below the frost line. Don't give the frost any chance to heave up walls or footings, porch walls included.

23. No part of the building is more important than the foundation. If there is the least doubt regarding the firmness of the soil, the excavation should be carried down to firmer ground, and the footing made wider by stepping off with more courses. Never place a wall on filled ground or spongy, springy soil.

24. If stone is encountered during excavation, of suitable character for footings or foundation walls, it may be economical to use it instead of brick below ground.

Drain at Footings:

25. It is advisable in almost all cases to place a porous tile drain at the bottom of the wall or at the footings to carry off any water which may accumulate. This drain should be laid with an even slope, the high point not above the floor level and the low point not below the bottom of the wall or footing.

26. The best way to avoid dips and traps in the drain is to lay it on a board with a strip nailed at the side to hold it in place laterally. The fill over the tile should be of dry material such as large stones or broken brick placed carefully on the tile—not dumped from a wheelbarrow—and the finer fill graded toward the top. The tile should be connected with the cellar floor or surface water drainage system.

Damp Proofing Basement Walls:

27. Except in extremely dry soils it is much safer to damp proof the basement walls, and this should always be placed on the outside of the wall.

28. To resist ordinary dampness the best damp-proofing is considered by many to consist of asphalt thoroughly well mopped boiling hot directly on the brick wall, which should be laid with struck joints. A mixture of three parts tar and one of pitch is sometimes used, and forms an excellent low cost damp-proofing. Tar alone is sometimes employed but soon becomes brittle and flakes off. A one-half inch coat of cement plaster is sometimes used, but is probably not as effective or reliable as mopping the wall as described.

29. If the soil is actually wet, the wall may be waterproofed by first mopping it thoroughly with boiling hot asphalt, and then applying one or two thicknesses of felt, with asphalt mopped between each ply and over the last ply. This treatment is expensive and need only be applied where water is actually present in the soil.

30. In very wet soils it is also advisable in some cases to waterproof the top of the footing to prevent moisture rising in the wall by capillary attraction. Two courses of slate, laid to break joint, or a strip of composition roofing will answer this purpose. As a further protection, a similar course may also be laid about 6″ above the grade line.

31. Coating 1000 square feet of brick wall with asphalt requires:—200 pounds hot asphalt, 4 hours attending fire and 4 hours mopping wall. A boiler will be required for heating the asphalt.

32. Cement plaster for damp-proofing the outside of basement walls below grade should be composed of one part Portland cement to two parts very coarse sand. (Par. 4, page 60.) The finish should be compactly troweled fairly smooth, but need not be floated.

33. The following quantity of material is necessary to cover 100 square feet of brick with plaster ½ inch thick:—2 bags Portland cement, 4 cubic feet sand, laborers time mixing plaster ½ hour.

34. An experienced man and good helper should cover 42 square feet of surface per hour.

Figure 3. A typical solid brick operation.

Basement Piers:

35. If local ordinances permit, basement piers may be economically built hollow with brick on edge, as shown in Plate 1.

Joist Support:

36. In brickwork, the courses can easily be adjusted so that the courses supporting joists will be at the exact height required. No "shims" or blocking under the joists are needed or should be allowed.

37. Joists and timbers should be set directly on the brick, unless their bearing surface is so small that they transmit a load over the safe bearing capacity of the wall, which occurs very seldom, but which would require bearing plates.

38. Never use wood bonding timbers. They will shrink and seriously weaken any wall.

Floor and Roof Anchors:

39. In the better class of residence work floor joists and roof plates are anchored to the walls. Some cities require this by ordinance. In the great majority of speculative residence work outside of such cities, however, anchors are not used. The attention of the reader, is especially directed to pars. 3 and 4, page 29, which apply equally well to solid or Ideal construction. Anchors are spaced approximately six feet apart both for floor joists and roof plate. Where joists run parallel to the wall the anchor straps are made long enough to be attached to about three joists, into which they are mortised on top.

40. When the joists are at right angles to the wall, anchors should be placed near the bottom of the joist to lessen the strain on the wall in case the joist burns away and drops out.

41. Roof plate anchors are built in as the wall nears that level. They are generally half inch bolts with a washer at the bottom and a nut and washer at the top.

Joists:

42. Joists with square ends should not be placed in a masonry wall, but the ends should be splayed or "fire cut" as shown in the plates. This enables the joist to drop out easily in case of fire without damaging the masonry.

43. A narrow space should be left on each side and at the end of every joist to allow the air to circulate around it and tend to prevent dry rot.

Firestopping:

44. Every wall should be firestopped at each story so that fire cannot spread through openings from floor to floor. A more complete statement as to the object of firestopping may be found in par. 34, page 43. Methods of firestopping Ideal and Economy walls have already been described.

45. Where a furred wall is offset from a thicker to a thinner wall, beam filling should be placed between the joists to the sub-floor level. Where the furred wall is the same thickness above and below the joists, one method of firestopping is to corbel* out the inside face of the wall two inches for the entire depth of the joist. The full thickness over the top of furring and plaster on the wall below should be capped, and the full thickness of the furring and plaster of the wall above should have brickwork beneath it. Another method is to run a piece of furring strip horizontally immediately below the joists, to which the strip is toenailed. This is shown in Fig. 12, page 30. In each case openings should be closed tightly.

46. Brick filling formed in cement should also be placed between the rafters above the roof plate and the slope of the roof sheathing. This acts as a windstop, and makes the house more comfortable in winter, as well as saving coal. This filling need not be more than 4″ thick.

Window and Door Sills:

47. Brick, terra cotta, or stone window sills should be used in a brick building. Cement sills poured in place or wood sills are not well adapted for this purpose, nor are they sightly or permanent. Stone window or door sills should be of such thickness that they line with the courses of brick, with a lug at each end.

48. Brick sills are the least inexpensive. The brick are laid on edge and sloped forward, with the bottom edge projecting about an inch to form a drip. The standard slope is 2″ to the foot.

49. To line the edge of the sill accurately a plank should be fastened to the wall and the brick placed upon it, as shown in Fig. 4, which shows also the way each brick is "buttered" with mortar before being pressed into place, 1:3 or, preferably, 1:2 cement mortar should be used. While the illustration shows a brick sill being placed under a steel frame after the latter is set, it is better construction to set the sill first. The latter should always be done with a wood frame.

50. To obtain the best effect, brick sills should be "slip sills," not wider than the actual masonry opening. Brick sills laid horizontally with a pitch formed with cement are not satisfactory, as the action of the weather may cause the cement to loosen.

51. In general, brick is the most satisfactory material for either window or door sills, although it may be made to form charming combinations with other materials. Where brick is used throughout, however, no material has to be specially ordered.

52. Brick is beautiful and flexible. An appearance of great solidity may be gained by sloping the brick window sills very sharply, thus apparently increasing the depth of the reveal of the windows.

Figure 4. Laying brick sill. Note board on which brick are lined.

*Corbel. Masonry projecting beyond the normal face of the wall. Used as a support, ornamental feature, firestopping, or for other purposes.

53. Brick for door sills should be hard burned. The standard slope for brick door sills is ⅜″ to the foot.

Window and Door Frames:

54. The only difference between double hung windows for frame and for brick walls is that the latter are boxed in at the jambs to provide a housing for the weights and that they have a staff bead outside. It is cheaper, however, to buy stock frames for brick walls with the box in place than to have the carpenter on the job make the box.

55. Frames should always be constructed so that there is no straight joint at the back of the frame from front to back of the wall. A "windstop" should be nailed on all such frames so that shrinkage of the frame will not allow drafts to blow through into the house.

56. Window and door frames for brick walls are made by all millwork companies. The Curtis Companies and their dealers carry a standardized line, particulars of which they will send on application. We suggest that contractors use standard sizes wherever possible. Frames of any size can, of course, be used with brick walls, the small brick units and numerous courses making adjustment easy to any dimension.

Setting Window and Door Frames:

57. Window and door frames are set by the carpenter, window frames being placed on top of the sill on a thin bed of mortar. A much better job is made if they are set before the wall has risen above the sill level. They are levelled, plumbed, and braced so that the braces will not interfere with the placing of the scaffold.

58. First floor frames are sometimes braced to stakes driven in the ground outside the house. The most convenient way, however, is to place an upright at about the centre of a small house, braced in two directions near the bottom with short pieces of plank. All the window frames on the story are then braced to the upright with braces placed horizontally, near the top of the frame, sloping braces being entirely avoided. This provides clear working space under the braces and scaffolding can be moved around at will. (Fig. 5.)

59. The carpenter should pile a few brick on the sill to assist in holding the frame steady. If he fails to do this, the bricklayer should place them himself before starting to brick the window in.

60. If a door frame or casement window frame is high a cross piece should be nailed on the frame to prevent the window being lowed in. The box stiffens a double hung frame considerably.

61. The openings for interior frames are generally formed in brick and the frames set afterwards.

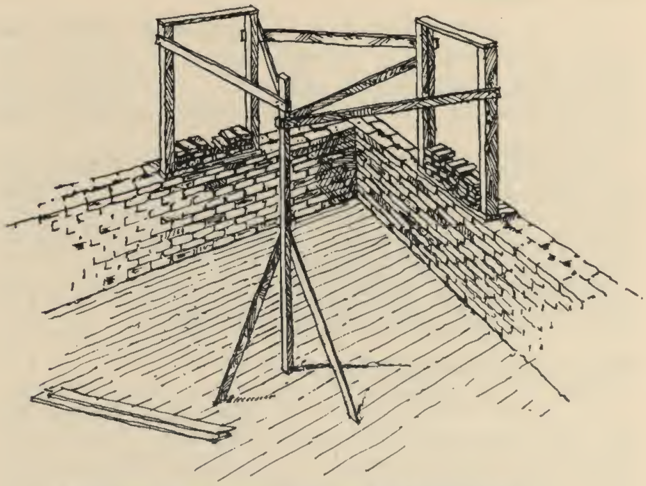
Labor Setting Window and Door Frames:

62. No more time is required to set window or door frames in a brick than in a frame house. The carpenter does the setting and bracing, the bricklayer simply bricks them in.

63. Setting, bracing, and plumbing a single, double or triple window frame or door frame requires from 25 to 30 minutes carpenters time.

Supports Over Openings:

64. Formed by arches of various types or by lintels. Over window and door frames, the brickwork the depth of the reveal is carried on the face arch or lintel, the backing carried on another lintel set higher than the face support, with or without a relieving arch above it. Where openings are arched, however,



METHOD OF BRACING WINDOW FRAMES TO ALLOW ROOM FOR SCAFFOLD BENEATH BRACES

Figure 5.

a less expensive and more general method is to run the arch the full thickness of the 8″ wall, and this method is shown on the plates. It has the disadvantage, however, of not providing such a good windbreak as the method first described.

65. In a small house, flat or practically flat lintels or arches over openings are to be preferred for the sake of appearance. The effect of a segmental arch is to increase the apparent size of the opening, and this may tend to throw it out of scale with the building.

66. A stone lintel should not be relied upon to sustain the load of the wall above. It is safer to support the stone with steel. Stone has uncertain transverse strength and may crack unless made too high for good proportion. A small mould of appropriate section over the top and at the sides of a stone lintel will produce a better effect than a flat lintel set flush with the brick wall, particularly where the lintel is three or more brick courses high. Do not use stone which contrasts too strongly in effect with the brickwork or the elevation may be restless and "spotty."

Rough Support of Backing:

67. Over a door or window opening the brick backing may be carried on a wood lintel. This is all the support required for backing over openings three feet wide and less; for when the mortar is set, brickwork will support itself over spans of this width, even though the wood lintel should burn or decay. For openings wider than three feet, a brick relieving arch should be thrown over the lintel, bearing on the wall at the ends of the lintel and not on the lintel itself. The space between the lintel and relieving arch should be filled with brickwork. This is built upon the lintel and shaped at the top to form a centre for the relieving arch.

Steel Lintels:

68. Where a flat soffit is desired a simple steel lintel may be used to support the outside thickness of brickwork over an opening with a 4″ reveal. A 4″ x 3″ or even 3″ x 3″ steel angle is generally sufficient for openings up to 4 feet wide, wider openings up to 5 feet require a 3″ x 5″ angle. If the reveal is 8″, two angles back to back should be used, preferably riveted together.

69. If both sides of the wall are exposed the whole thickness should be carried upon the steel.

70. If the floor joists above are close to the top of the opening below, care should be taken that the lintels are strong enough to carry them.

Painting Steel Angles:

71. Before setting the angles, the surface and ends which will be buried and concealed in the masonry should first be thoroughly painted with graphite or red lead and oil.

Soldier Course Over Angles:

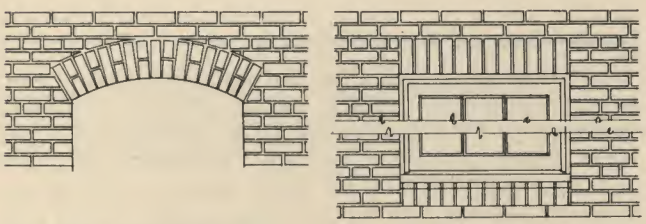
72. A soldier course of brick on end is frequently placed over a steel lintel. Very often the mistake is made of making this course wider than the opening. A much better effect will be gained by making it no longer than the width of the opening, similar to the brick on edge "slip sill" already mentioned.

Bearing of Lintels:

73. Wood or steel lintels should generally be made 8 in. longer than the openings, giving 4 in. bearing at each end.

Types of Brick Arches:

74. Flat, segmental, semi-circular and elliptical arches are commonly used. In the latter type a more pleasing outline may be obtained by laying out the curve freehand than by using a true ellipse constructed mechanically. A true ellipse has too great a radius at the spring line.



SEGMENTAL ARCH WITH ALTERNATE HEADERS AND STRETCHERS

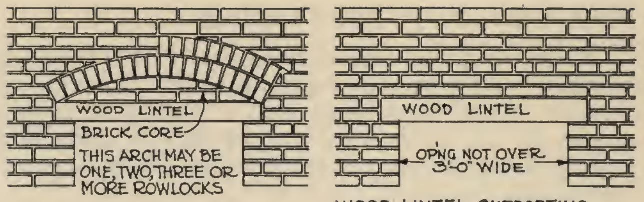
ELEVATION OF WINDOW WITH BRICK SILL AND SOLDIER COURSE OVER STEEL LINTEL

Figure 6.

The Flat Arch:

75. Although, in theory, a flat or "jack" arch is a true arch, capable of bearing a load, in practice it is weak and should be supported on steel if the opening is over two feet wide. The steel should of course be bent to the camber, if any, of the soffit.*

76. If the very best effect is desired, jack arches should be constructed so that the radial joints are the same width for the whole length of the joint.



WOOD LINTEL AND RELIEVING ARCH SUPPORTING BACKING

WOOD LINTEL SUPPORTING BACKING

Figure 7.

To make a perfect job either special brick must be made or the bricks rubbed to a wedge shape. Either of these methods is, of course, expensive.

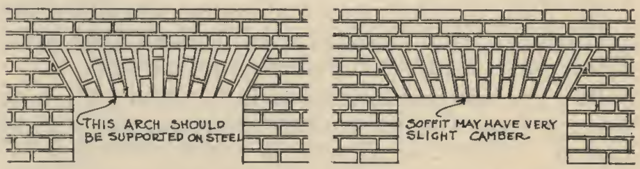
77. The brick should also be shaped so that the joints at the ends of the brick within the arch are horizontal, instead of at right angles to the radius of the arch. (Fig. 8 and Fig 1, page 65.)

78. Inasmuch as a perfectly horizontal soffit, especially a wide one, appears to the eye to sag in the middle, a slight camber may be formed in the soffit to correct this.

Segmental and Semi-Circular Arches:

79. The strongest type of arch is the segmental, where the abutment is ample to resist the thrust. With small abutments the semi-circular arch is safer.

80. For openings over windows and doors in residences the segmental arch is the type almost always used. The rise of a segmental arch will, of course, depend on the architectural design. A good rule to follow, however, is to make the rise equal to one-eighth the width of the opening.



INEXPENSIVE TYPE OF FLAT OR "JACK" ARCH. BRICKS NOT RUBBED TO WEDGE SHAPE HORIZONTAL JOINTS AT RIGHT ANGLES TO RADIUS OF BRICK. BRICK RUBBED AT SOFFIT AND TOP ONLY

BETTER TYPE OF FLAT OR "JACK" ARCH. BRICK RUBBED TO WEDGE SHAPE AND RUBBED TO FORM HORIZONTAL JOINTS TOP AND BOTTOM OF EACH BRICK

Figure 8.

81. For relieving arches and for arches in basements the rise from spring line to soffit may be made one inch for every foot of opening.

82. In the very best work, the bricks in segmental arches where rowlocks are 9″ wide are rubbed to wedge shape, but for ordinary residence work the curve is taken up in the joints, by making them wider at the top than the bottom. Bricks are sometimes chipped to wedge shape by the bricklayer.

83. The strongest arches are bonded by headers, as in the case of a brick wall.

Centering:

84. Centering for arches is furnished, set, and struck by the carpenter.

85. Over windows and doors having a 4″ reveal, the face arch may be constructed without centering; the window frames with the staff bead in place furnishing sufficient support.

*Soffit. An under surface.

Cost of Supports Over Openings:

86. For ordinary residence work with 4″ reveals to windows and doors the segmental arch is the lowest in cost. A flat steel lintel with or without a soldier course on top costs a little more than a segmental arch but may present a better appearance, depending on the design.

87. Segmental face and relieving arches set in 4″ rowlocks, and soldier courses over steel lintels, take practically no more time to set than the brick in the rest of the wall, and nothing extra should be figured for them.

88. Where brick are roughly chipped to wedge shape the cost of the chipping only should be added. A bricklayer can chip about 40 brick per hour.

Brickwork Carried by Arch or Lintel:

89. It should not be assumed that a strip of brickwork to the top of the wall, the same width as the opening, is carried by the support. Brickwork tends to arch itself over. A section of brickwork forming an equilateral triangle, each side having the same length as the width of the opening, should be assumed to be carried by the support. The weight of any floor construction within or near the top of this area should, of course, be added.

Pipes in Brick Walls:

90. Electric conduits, gas pipes, and small water pipes may be built within a solid wall as it goes up, and they can easily be placed in a sloping position in Ideal walls after the latter are built.

91. Four inch soil pipes may be brought down and concealed in an 8″ solid or Ideal interior brick wall. These pipes measure 6 inches over the hubs.

92. The method employed for a solid wall is to leave a chase 4½ inches deep where the soil is to be placed. When the plumber is ready to "rough in" his work, a small section of brick about 2½ inches wide and 1 inch deep is chipped out from the back of the chase behind the exact location of the pipe unless the wall is to be furred or stripped, when no chipping is required. Where the hub of the pipe occurs one brick may be taken out entirely. Gas and water pipes may also be run in these chases. The open side of the chase is covered with wire lath and plastered with the rest of the wall. The holes on the other side of the wall, where brick were removed at the pipe hubs, should also be covered with wire lath. (Plate 4.)

93. In an Ideal all-rolok wall the 4″ soil pipe will fit the hollow space with a little chipping, a brick being left out at the hubs.

94. Soil and water pipes should always be placed within interior partitions to lessen liability of freezing.

Duct Chases:

95. Hot air ducts may also be set in 8″ solid or Ideal walls. Leave a chase slightly wider than the width of the tin ducts, and after the duct is set cover with wire lath. (Plate 4.) Ducts run in brick walls do not need to be covered with asbestos. As with plumbing pipes, heat ducts should never be run in outside walls.

Bay Windows:

96. There are many ways of building bay windows in brick. The example shown on Plate 4 illustrates one method for a solid wall by which cutting the brick at the corners is reduced to a minimum, while presenting a very neat appearance. Each half of the plan shows an alternate course of brick.

Furring:

97. For data on the application or omission of furring to Ideal walls see pars. 23-30, page 16.

98. Under favorable conditions in some localities plaster may be applied directly to the inside of 8″ solid brick walls. A house built several years ago in northern Iowa with walls 8″ thick laid with impervious face brick is plastered inside directly on the brick without any ill effect being noted. Generally speaking, however, it is safer to furr the inside of any ordinary exterior 8″ masonry wall.

99. Furring may be of wood, metal, or hollow tile.

100. Wood is ordinarily used, formed of 1″ x 2″ strips placed vertically, spaced 16″ on centre. In the cheapest work the strips are nailed into dry mortar joints, in better work to lath placed by the masons in the joints, or the walls may be plugged with wood plugs left projecting, and sawed off so that the strips will lie in an even plane, thus correcting any irregularities in the surface of the wall. Nailing to lath or to plugs also makes a more secure job than nailing into brick joints. The strips should be trued up where necessary by wedging behind them. Recent investigations show that furring strips placed horizontally will conserve heat in cold weather and also make effectual firestops.

101. Split furring tile 3″ or 4″ thick, which are scored so that they can be split in half, are sometimes used. The tile is set without mortar and anchored at every second course by driving ten penny nails into the mortar joints over every third tile. Tile provides a good surface upon which to plaster.

102. Metal furring is employed when metal lath is used and may consist of small steel rods or stiffening members in the metal lath itself.

Labor Cost of Wood Furring:

103. On an ordinary job furred with strips nailed to lath or directly into dry joints, a carpenter should place about 80 lineal feet of wood furring strips per hour or 640 lineal feet per day. He should plug the wall and place about 30 lineal feet of furring per hour or 240 feet per 8 hour day.

Basement Paving:

104. If the soil is firm and dry, basement paving may consist of brick on edge or flat laid upon a bed of sand not less than 2 in. thick. The sand is tamped or rolled level and the joints afterwards carefully poured full of cement grout, the brick being wiped clean before grout has set. Another method is to sweep the joints full of cement grout with a broom. Methods of laying brick walks and steps apply also in general to basement paving. (Pars. 3 to 16, pages 88 and 89.) A cheaper method even than this is to sweep the joints full of sand as described for

garden walks. Salt should be mixed generously with the sand to eliminate all danger of vegetation appearing between the joints. If the soil is not firm, however, the floor laid by either of the foregoing methods may become irregular in time. If there is any doubt about the firmness of the soil or if it is not quite dry, place a 3″ bed of lean 1:8 concrete under the floor with the brick wearing surface on top. (Plate 4.)

Number of Bricks in Basement Paving:

105. Figure the area of the paving in square feet. If brick are on edge read number of brick required from Table 6, page 94. If laid flat, figure 4 brick per sq. ft.

106. Allow 1½ cubic feet sand to every square yard paving for cushion 2 inches thick.

Grout for Basement Paving:

107. Grout should be mixed in the proportion of one part Portland cement to 3 parts sand, made thin so it will run down and fill the entire joint. Approximately 3 bags cement and ⅓ cubic yard sand are required for every 1000 brick laid with joints 3/16″ to ¼″ wide.

Laying Brick Paving:

108. A laborer will spread, level and tamp 125 square feet sand cushion 2 inches thick per hour.

109. A bricklayer laying brick on edge should lay all the paving brick in the basement of any house of moderate size in about half an 8 hour day, leaving the joints open for filling with cement grout or sand. Laborers time handling brick and helping mason about 10 hours.

110. One laborer can grout 70 to 80 square feet of brick flooring, sweeping it in with a broom, in one hour.

Cleaning Brickwork:

111. All exposed brick should be scrubbed soon after completion with water and not more than 5% by volume muriatic acid or about one pint to four gallons of water. A stronger solution may injure the wall. Afterwards scrub thoroughly with clean water to remove the acid.

112. A man should cover about 95 square feet of brickwork per hour.

Vaulted Wall Construction:

113. A type of hollow wall construction much used in some localities on this continent and very frequently in Europe, consists of two walls of brick laid flat, separated by a two inch air space and connected with metal ties. In this country the wall is generally constructed with a total thickness of ten inches. A fourteen inch thickness is sometimes employed. This wall is an excellent type of construction for residences but costs more than the eight inch Ideal or solid wall and cannot be as strong as either of these types; also the metal ties will be apt to rust away in time.

114. This wall is built upon the same basic principle of the ventilated air space as the Ideal wall and its invariable success is but another proof of the soundness of this principle.

115. Furring is not required with a ten inch wall of this construction, except under the same limitations for intensely cold climates as described for the Ideal wall.

116. Fire stops are not required with this wall.

FIREPLACES AND CHIMNEYS

Material for Chimneys:

1. Solid brickwork is the safest and most satisfactory material to use for chimneys and flues. If a chimney fire occurs considerable heat may be engendered in the chimney, and the safety of the house will then depend upon the integrity of the flue wall. It is dangerous to use hollow units for this purpose, for these cannot stand high temperatures without danger of cracking and spalling. Salmon brick may be used for chimneys below the roof line.

The Brick Fireplace:

2. The comfort and pleasure of a home may be vastly increased by a fireplace in the living room and the most appropriate and the safest material of which to build, both the fireplace and mantel, is brick.

Location:

3. A fireplace is the outstanding feature of any room in which it is placed. Furniture is arranged with the fireplace as the starting point and the latter should, therefore, be in the natural focal point, as it were, of the room. It should thus be placed at the narrow end of the room, out of line of travel and away from the entrance. A fireplace looks awkward and tends to dwarf the room when placed on its broad side. Moreover, the hearth will project so far that it will cause difficulty in placing the rug.

Efficiency:

4. Properly constructed, a fireplace will aid greatly in heating the room. Poorly constructed, most of the heat will go up the chimney.

5. To obtain the greatest efficiency, the heated gases should be made to travel horizontally as far as possible over the brick radiating surface before passing into the flue. The back is therefore made to slope outwards as much as possible, the slope starting at about the top of the fire and the throat placed well forward. In plan, the sides of the fireplace should have considerable splay so that they also will radiate heat into the room. A damper will help to regulate the draft. In European countries, where heating is accomplished almost entirely by open fireplaces, there are patented systems whereby heated air is supplied at points below the fire, thus helping to secure more complete combustion and greater efficiency.

Area of Openings:

6. The Manual of Face Brick Construction recommends the following proportions for fireplace openings:

Size of Fireplace Openings

Width	Height	Depth
2'8"	2'4"	17" to 21"
3'0"	2'4" to 2'6"	21"
4'0"	2'8"	21" to 25"

Hearth:

7. The front and back hearth is generally laid of the same brick as the mantel, either flat or on edge. Sometimes the back hearth is of firebrick. The portion projecting into the room rests upon a "trimmer arch", as shown in Plate 9, thrown from the fireplace to the header joist, the filling between the trimmer and the hearth being either lean concrete or mortar.

8. An ash dump, emptying into an ash pit with a cleanout door at the bottom, is a great convenience.

Sides and Back:

9. These also may be formed of the same brick as used for the mantel. Firebrick is sometimes used. The back should be perpendicular for two or three courses, sloping or curving outwards from this point.

Damper and Lintel:

10. There are several good types of damper on the market which also form a lintel to carry the brickwork across the opening. Their use is strongly recommended. Where not used, a separate damper should be placed and the brickwork carried on a steel lintel, except where an arched opening is preferred.

Smoke Shelf:

11. Placing the throat well forward has another advantage—that of forming a smoke shelf at the damper level. This shelf aids in stopping the down drafts which will almost invariably occur if the back of the fireplace is made to rise vertically in the same plane as the back of the flue.

12. The opening above the smoke shelf should be "gathered" or contracted to the size of the flue by corbelling, this being done within the least height practicable. Up to the level of the clay flue lining the brickwork should not be less than 8" thick, for the space immediately above the damper is the hottest part of the chimney. The flue is generally centered over the fireplace but there is no disadvantage in placing it on either side.

Construction of Fireplace:

13. To prevent the finished mantel being spotted with plaster, the rough work only is installed first, the mantel and hearth being built after the plasterer has finished his work.

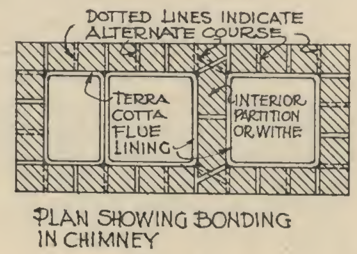


Figure 9.

Separate Flues:

14. Every fireplace should have a separate flue carried to the top of the chimney, with no other connections. Smoke may easily be carried by down drafts through connections and openings which are not in use.

15. Not more than two flues should be in the same chimney space. Where there are more than two flues, each third flue should be separated by a "withe" or 4" brick partition. (Fig. 9.)

Thickness of Flue Walls:

16. The least expensive way to build these is to make the walls 4" thick, lined with burned clay flue lining. With walls of this thickness never omit the lining or replace it with plaster. The expansion and contraction of the chimney would cause the plaster to crack and an opening from the interior of the flue through which flame could pass might eventually be formed. See that all joints are completely filled with mortar.

17. If flue lining is not used, the walls should be not less than 8" thick, with joints in the flue carefully pointed. In Europe, a mixture of cow dung and lime plaster is used for plastering flues, and is found to crack but little. The plaster is applied as the flue goes up. A bag of shavings fitting the flue tightly may be drawn up by a rope attached to the top of the bag as the flue is built to catch the plaster droppings. The latter is not only useful but very important also in a flue in which clay lining is used, and in which there is an offset, and may save much trouble and cost to contractors in cleaning out flues after completion.

Setting Flue Linings:

18. The flue lining should extend the entire height of the chimney, projecting about 4 in. above the cap and a slope formed of cement to within 2" of the top of the lining. This helps to give an upward direction to the wind currents about the top of the flue and tends to prevent rain and snow from being blown in.

19. The flue space should not extend up from the foundation but only about a foot below the first connection. The furnace flue should have a cleanout door. Be careful that there is no connection between the flues at the bottom or trouble may be experienced with the draft.

20. Fill all the joints of the flue lining and the space between the lining and the brickwork tightly with mortar.

Chimney Pots:

21. To improve the draft of chimneys already built or to provide an artistic finish for new chimneys, there is a variety of chimney pots of various designs available. The most durable and sightly chimney pots are those of burned clay.

Size of Flue Linings:

22. The following is a table of sizes of clay flue linings. The recommendations of heating apparatus manufacturers should be followed regarding flue sizes and heights. For fireplaces the flue should not be less in net area than one tenth the area of the fireplace opening.

23. The most efficient shape of flue is a round flue, next to that a square flue. Currents in a chimney rise with a circular swirling motion.

Size of Rectangular Flue Linings

Outside dimensions	Net inside area
8½ in. x 8½ in.	52 sq. in.
8½ " x 13 "	80 " "
13 " x 13 "	126 " "
13 " x 18 "	169 " "
18 " x 18 "	240 " "

Supports for Chimneys:

24. A wall to support the fireplace and adjacent flues should be built up from a footing in the basement. This wall may be hollow to form an ashpit. Small isolated chimneys may be supported on corbels built out from the wall, although it is better practice in every case to carry the support right down to a bearing below the basement floor.

Chimneys, General:

25. Keep all woodwork—joists, furring strips, rafters, etc., at least 2 inches away from all flues and brick chimney breasts. Above all, never rest any woodwork on the walls of a flue. The partitions between flues (called withes) should be bonded as shown in Fig. 9, page 84.

26. Run each flue vertically from top to bottom if possible to secure the best draft and make it easier to clean. If offsets are necessary, make them gradually or wind currents may occur in the chimney, causing it to smoke. Soot may also lodge in bends that are laid too flat. It is also difficult to cut clay flue lining to make a perfect joint at an angle. Make the slope no flatter than 30 degrees from the vertical.

27. The chimney should be run up at least 1 ft. above the level of the highest ridge to prevent downdrafts. 2 ft. is better. Chimneys constructed entirely within the house are more efficient than chimneys on the outside wall, the former allowing the flues to become hotter, giving a better draft.

28. According to the National Board of Fire Underwriters Chimney Ordinance, mortar for chimneys should be composed of 2 bags Portland cement and 1 bag hydrated lime mixed together thoroughly while dry, added to three times its volume of clean sharp sand. 1 cubic foot of lump lime putty may be substituted for the hydrated lime.

Labor on Chimneys, Flues and Rough Fireplaces:

29. A bricklayer should lay 1000 brick in lime or cement mortar in rough fireplaces and flues in 14 hours. This also includes setting clay flue lining. Helpers time same as bricklayers, if one bricklayer is working. If two or more are working, helpers time 7 hours per 1000 brick.

Labor Building Ash Pit:

30. An ash pit in the basement costs about the same as building a flue.

Labor Building Brick Mantels:

31. One bricklayer should build an ordinary brick mantel including the lining for a fireplace of usual size in 12 hours. Laborers time same as bricklayers if one bricklayer is working. If two are working, laborers time 6 hours. This labor is for the finished brick mantel and lining not including the hearth.

32. On a more elaborate fireplace in Common, Flemish, or English bond with panels or pilasters, a bricklayer should lay about 400 brick per 8 hour day. Helpers time the same as bricklayers if only one bricklayer is working. If two are working, ½ hour laborers time to one hour of bricklayer time.

Laying Brick Hearth in Square or Herringbone Pattern:

33. A bricklayer should set both the front and back hearth of an ordinary fireplace in half an 8 hour day.

Number of Bricks in Fireplaces:

34. To figure the number of bricks in a fireplace, multiply the width of the fireplace by the height from floor to floor and figure it as a solid wall.

35. Then deduct an area equal to the brick displaced by the flues and fireplace from the total area given above. Find material quantities in tables.

Chimney Ordinance:

36. An excellent ordinance covering in detail the construction of chimneys may be had free upon application to the National Board of Fire Underwriters, 76 William Street, New York City.

EQUIPMENT FOR BRICK CONSTRUCTION

(See also "Equipment for Mortar Making," Page 64.)

General:

1. The following deals mostly with equipment required for an ordinary house job.

2. Scaffolding can be used many times over on a number of jobs and its first cost should be charged to equipment.

Shed:

3. A small storage shed should be built on the job to keep cement and lime dry. On a small job, one corner of this shed near the door can be fitted with a window and a rough desk to serve as an office. Toward the completion of the job the shed may be taken down and the boards used for cellar shelving. The cost of the shed should be added to the cost of the job.

Make Scaffolding Safe:

4. Great care should be used to make scaffolding safe. Scaffold accidents are by no means uncommon and are due in most cases to carelessness. "Blind traps," or boards that tip up when walked upon, should be avoided by not allowing the ends of the boards to project more than six inches over their support.

Scaffolding, Where Required:

5. In building the lower part of the basement wall the mason stands in the excavation, the upper part being built from the grade. Scaffold plank on trestles is required in the basement only for independent chimneys and piers.

6. Walls above the first floor line are built from inside the house. In all but the cheapest construction a rough underfloor is used and this floor is laid immediately the joists are placed. The mason builds the lower 4 to 4½ feet of each story from the sub-floor, scaffold plank on trestles being placed when the wall reaches this height. Where the finished floor is only of one thickness, rough plank flooring must be laid temporarily on the joists, this plank being moved up to the next story when the lower story wall is finished.

7. Walls can be cleaned down from a ladder, or a painter's scaffold may be employed. On higher buildings scaffold brackets may be used to support plank for this purpose if brickwork is cleaned down before plasterer starts, otherwise exterior scaffolding must be used.

8. The carpenter will need an exterior scaffold of some kind to work on the overhanging eaves or cornice.

Trestles and Scaffold Plank:

9. Fig. 10 shows the usual trestle and plank arrangement.

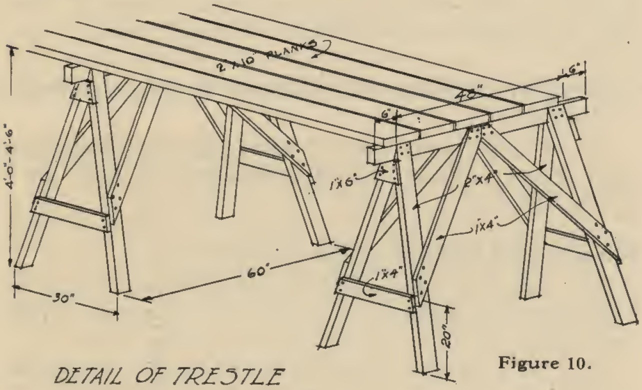


Figure 10.

10. Trestles may either be built as shown in Fig. 49 or hinged at the top to fold flat. In the latter case iron hooks and eyes may be used to spread the bottom of the trestle the proper distance apart. Some contractors prefer to bore holes through the bracing or legs, keeping the latter from spreading by passing a rope through the holes, knotted outside. The hinged variety of trestle may be loaded more easily on a wagon.

11. Always keep the trestles 3 inches away from the inside face of the wall so the swing of the scaffold will not push the newly laid wall out of line.

12. Plank for scaffolding should not be less than 2″x10″. Sometimes the floor joists intended for a floor above having a plastered ceiling are laid on the trestles and used for scaffold planks. If the basement is not to have a plastered ceiling, this use would get first floor joists too dirty. When the wall is built to the height of the bottom of the joists the scaffold planks are swung up to form the joists. If hemlock joists are used this practice should not be followed. Some states have laws prohibiting the use of hemlock for scaffolding.

Scaffold Brackets:

13. Scaffold brackets for cornice work, the same as those used for frame house construction, are used by Andrew Pentland, Cleveland home builder (Fig. 11). To place upon a newly laid 8″ wall the severe side pull of one of these brackets would tend to throw the wall out of line. This is avoided by placing an upright 2″x4″ against the inside of the wall behind each bracket, extending over the plate. A 1″ piece is placed against the plate to take care of any irregularity of the wall or bend of the 2″x4″. The plate is, of course, held in place laterally by the ceiling joists being spiked to it. When the ceiling joists run parallel to the wall, the plate or the upright 2″x4″ may be braced with a diagonal 2″x4″ extending at the bottom some distance from the wall and nailed to anything convenient, such as a floor joist.

14. The height at which the scaffold will be required is determined before the wall is built and suitable bolts are

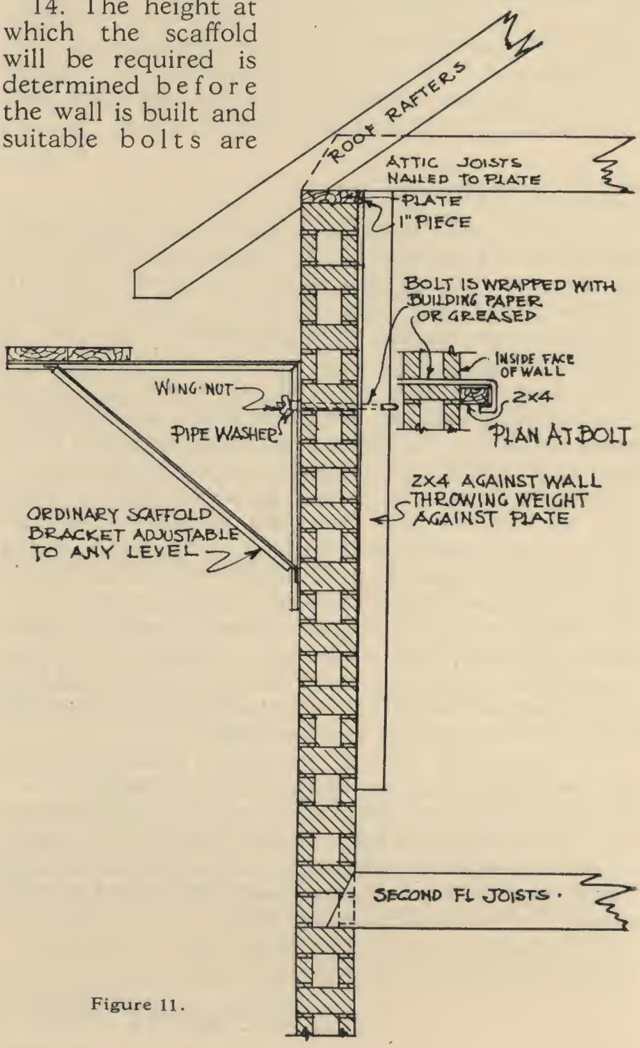


Figure 11.

built into it, greased or wrapped in building paper, being knocked out when the scaffold is taken down.

15. Mr. Pentland states that the use of these brackets saves a very worth while amount of money on each house over the more general method of using built up scaffolding and saves also the cartage of the material used for this scaffolding to another job.

Material Runs:

16. Brick and mortar are generally handled in wheelbarrows for walls up to the height of the second story joists, and a sloping 2″x10″ plank wheelbarrow run should be laid from grade through a convenient door opening to the first floor line.

17. Above the line of the second floor joists materials are most conveniently handled in hods. An inexperienced man will at first have difficulty in

carrying a full hod up a ladder and some contractors prefer to use cleated runs of 2″x10″ instead. An experienced man much prefers a ladder.

Mortar Boards:

18. At about five to six foot intervals along the wall to be built, mortar boards, as shown in Fig. 12, should be placed. This should be done regardless of the number of masons building the wall. Much time will be lost if mortar boards have to be constantly moved. If there are three or four mortar boards per man, however, these boards should not be kept so full of mortar as when there is a man to every board, or the mortar will get stiff.

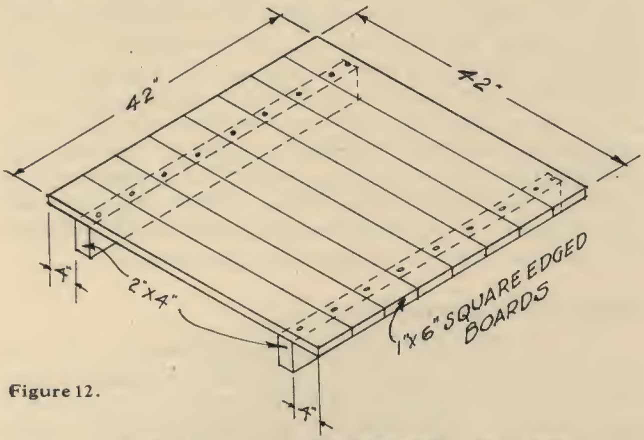


Figure 12.

DETAIL OF MORTAR BOARD

19. The boards should be made of square edged material. If matched stuff is used, it may splinter when a trowel is thrown point downwards to stick into the board.

20. For a very fine face brick job with buttered joints, mortar boards about ⅓ the size of the ordinary mortar board, standing on legs 2′ 6″ high, are used.

Straightedges:

21. The contractor should provide two or three straightedges for each job shown in Fig. 13.

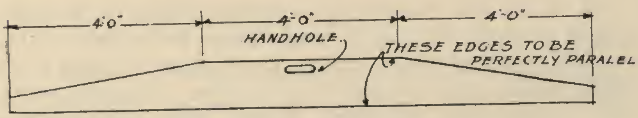


Figure 13. DETAIL OF STRAIGHT EDGE
MATERIAL – 1⅛"x 6" WHITE PINE

Wheelbarrows and Hods:

22. For a small house, on which one or two masons are employed, one wheelbarrow is sufficient.

23. One brick hod and one mortar hod should also be provided for a small job. The average brick hod is 21 by 7 by 7 in. and holds 18 bricks. The average mortar hod is 24 by 12 by 12 in. and 12 in. across the top.

Line:

24. In some localities it is customary for the contractor to provide the bricklayers with line; in others the masons furnish their own. The line in the average mason's kit bag, however, leaves much to be desired and regardless of custom it will generally pay the contractor to furnish the line. Line rotted by lime or cement breaks easily and soon gets full of knots, the loose ends getting into the joints and cutting down the efficiency of the bricklayer. Moreover, when the line breaks, the bricklayers must stop until it can be tied and reset. Line costs only a few cents and it is real economy for the contractor to furnish it.

Large Scaffolds:

25. In constructing larger scaffolds it is important that they be thoroughly braced laterally and either well tied to the wall or braced against adjoining buildings. Fig. 14 shows the use of spring stays, in which two boards are placed in the face of the wall and a wedge driven tightly between them. The boards must be well spiked at the other end.

26. Watch the uprights and at the first sign of buckling or bending add another brace.

27. In placing stringers, running strips or ledge boards, nail them securely at every point of contact and nail each joint completely before passing to the next. It sometimes happens that a ledge board is tacked in place temporarily at one end and left

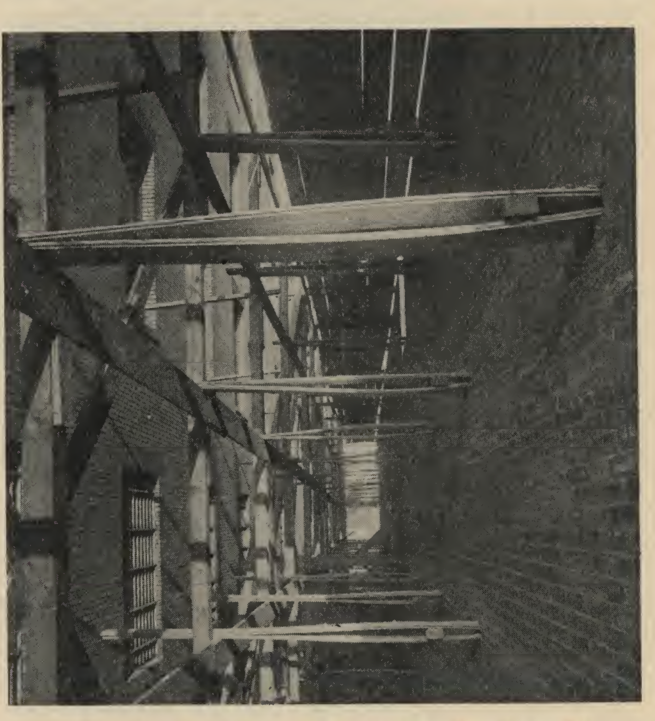


Figure 14. Spring Stays, holding scaffold securely to wall.
(Courtesy Travelers Insurance Co.)

while the other end is being nailed, the fact that the nailing at one end was temporary being forgotten. The supporting members should rest on a solid foundation or a wood cross piece of the required length nailed beneath them.

BRICK CONSTRUCTION IN FREEZING WEATHER

Cold Weather no Obstacle to Good Work:

1. Good brickwork can be produced in freezing weather and operations successfully carried on during winter weather. Considerable difficulty has been found in demolishing old brick walls constructed in Winnipeg, Canada, through the coldest portion of intensely cold winters. It is the custom today at all important summer resorts to do all construction work throughout the winter. Countless buildings, large and small attest this fact.

Mortar:

2. Portland cement mortar only should be used in freezing weather. Freezing temperatures injure natural cements and lime mortar sets too slowly.

3. It is better not to mix lime with the cement mortar, but in the event that it is used, only just enough lime to barely make the mortar workable should be added, for lime delays cement mortar taking initial set.

Brick:

4. Impervious bricks are laid with more difficulty in freezing weather than are non-impervious brick.

5. Do not wet brick laid in freezing weather. Bricks should be thoroughly dry. No ice should be on them when laid in the wall. Much money will be saved in bricklayers' time if the brick piles are kept covered with tarpaulins.

Heating Materials:

6. On a small job in a moderate climate it may be possible to avoid the expense of special equipment. Manure may be spread on the soil around footings to prevent penetration of frost beneath them. Sand may be piled in a long high heap. The top and sides of the heap will freeze and sand for use can be tunnelled from the ends. The openings at the ends should be kept closed. Frozen sand must not, of course, be used for making mortar. Mortar should have attained its initial set before it freezes, although some contractors who have successfully carried on operations in freezing weather are satisfied if the mortar can be kept from freezing until placed in the wall. A salamander or fire kept going near the box will help in preventing the mortar from freezing.

7. In severely cold weather, however, and on larger work the following methods may be followed and equipment used.

8. All materials, including brick, water, cement and sand should be heated so that the mortar will be about 60 degrees when bricks are laid. Sand may be heated most conveniently by running horizontally through the material pile a corrugated sheet metal culvert about 20″ in diameter and 10 ft. long or an old steel chimney stack or any other circular iron section, keeping a fire going at one end. Water may be heated in a coil attached to the water main with a fire in the centre or in an iron can placed over a fire. Water should not be allowed to get much hotter than 165 degrees or it will injure the mortar. If the water boils, cool it with cold water.

Lowering Freezing Point of Mortar:

9. Salt or calcium chloride may be added to the mortar to lower its freezing point. Both these substances have the great disadvantage, however, that they may cause efflorescence on the face of the wall. A small amount of salt, not exceeding 5 per cent by weight of the water, may be added to the water with which the mortar is mixed. Calcium chloride lowers the freezing point much further than salt, and accelerates the hardening of the mortar. A 4 per cent solution will usually be sufficient and will not affect the strength of the mortar.

Screens for Bricklayers:

10. As stated in Par. 6, it is often possible, where the cold is not too intense, to run a small job in winter without special equipment or protection, and this applies also to protection for bricklayers, although bricklayers are, of course, more comfortable in an enclosed space heated with salamanders.

11. A screen may be constructed of canvas or tarpaulins on light wooden supports, forming an enclosure over the wall being built, with openings for material, etc. Salamanders fired with coke will keep the enclosure comfortable and help the mortar to set. Do not use coal—its gas affects the workers.

Keep Walls Even:

12. If a wall is carried up several feet in a day on one side of the house only, there may be some danger of throwing it out of plumb if the warm rays of the sun strike it. It is better practice to build a less height per day and keep the walls at an even height all around the house. Clipped bond and metal wall ties should be avoided in freezing weather, and headers should be placed at least every 6th course.

Close Up Each Story:

13. Each story should be closed up as soon as the floor joists are laid. Rough flooring above should be placed and openings boarded up, using building paper to cover the cracks. Salamanders should be used to raise the temperature and dry out the wall for the plasterer.

Keep Going in Winter Weather:

14. It is not necessary to shut down in winter. Many operations, small and large, have been successfully put through in cold weather. There's no profit when the work is closed down. By following the suggestions outlined above, the contractor's organization can be kept together and provided with work and the contractor's balance sheet will look better at the end of the year.

BRICK FOR GARDEN USE

Permanent and Most Economical:

1. Brick possesses the same qualities of durability and beauty for outside uses as for the walls of the home. Brick harmonizes well with any garden, formal or otherwise. Creepers and vines cling well to it and do not cause it to decay. Its beautiful colors and soft texture, forming a background for foliage and flowers, look cool and inviting even on the hottest summer day. It does not "glare" in the sun, and it links house and garden into one harmonious design.

2. Summer houses, garden walls, seats, steps, pergolas, gate posts and walks, form but a few of the instances where advantage may be taken of the unrivalled beauty, permanence and ultimate economy of brickwork.

Brick Walks:

3. Brick for this purpose should be hard burned. Ask the manufacturer whether his bricks are suitable for this use. Walks may be laid in one of two ways, either on sand or cinders or on a concrete base, in the latter case with mortar or sand joints.

4. For those who prefer a walk to be a little irregular, perhaps with grass growing up in the joints, the first mentioned method is recommended. Grass can easily be kept down if desired, however, by salt being mixed with the sand. The bricks can be laid either flat or on edge.

5. A method of laying walks by this method is illustrated in Figs. 15-16. First excavate the soil to the depth of about 4 inches. Lay 1 inch thickness of sand for the border brick, which are placed on edge. Then lay and tamp or roll a 2 inch bed of sand or cinders for the rest of the walk, placing the bricks flat. It is important, especially in a clay soil, to thoroughly drain the sand or cinder bed. If bricks are on edge the excavation should be proportionately deeper. Leave about ½ inch space between the bricks. As soon as they are laid, fill the vertical joints by placing a layer of sand on the walk and sweep it into the joints with a broom. Leave the sand on the walk for a few days, agitating it once or twice a day, so that the joints will be completely filled. Tight mortar joints may be used, however, as described in pars. 7-9.

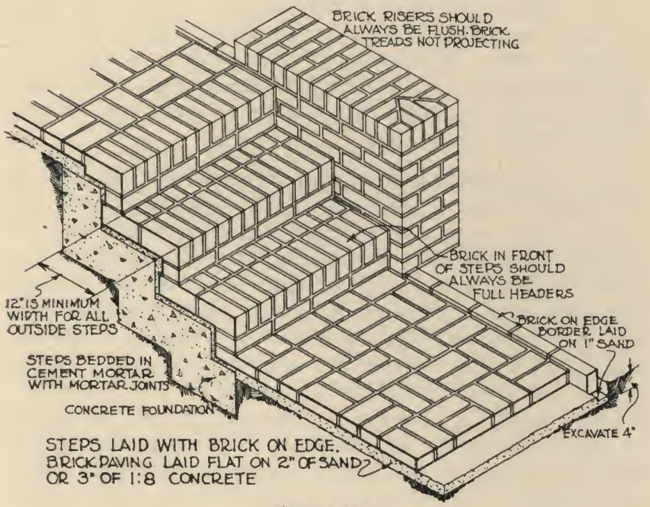


Figure 15.

6. A concrete base will ensure the walk remaining rigid and even. (Plate 4.) A lean 1:8 concrete should be used, 3″ thick, laid on a bed of cinders or sand, thoroughly drained. The brick may be laid on a ½″ setting bed of cement mortar or upon a bed of sand just thick enough to straighten out the irregularities of the rough concrete. The curb may be formed of concrete or of brick on edge. The vertical joints may be sanded, or filled with mortar.

7. In the latter case the most satisfactory but most expensive method is to trowel the joints (par. 16). A cheaper way is to broom the joints full of a thin 1:3 cement grout, but this has the disadvantage of smearing the surface of the brick with mortar, which may, however, be removed by going over the surface while the mortar is soft with a scrubbing brush and water containing not more than 5% of muriatic acid, afterwards removing the acid by scrubbing again with clean water.

8. Another and better method is to carefully pour the grout into the joints, wiping the brick clean before mortar has set.

9. If bricks are laid with tight mortar joints, the walk should be slightly crowned for drainage if on flat ground. If laid with sand joints on concrete, the latter should have a slight crown.

Labor laying Brick Walks:

10. A laborer should spread, smooth and tamp 125 square feet of sand in one hour. A bricklayer should lay 2500 brick for paving laid flat per 8 hour day as shown in Fig. 16.

11. Laborer's time for handling brick will be double bricklayers' time, and add 2 hours per thousand sweeping joints full of sand.

12. A laborer can grout 70 to 80 square feet of brick paving per hour, sweeping it in with a broom.

Number of Bricks in Walks:

13. If the walks are to be laid with brick on edge, figure the number of bricks by finding the area and reading the number of bricks required for a 4 inch wall, table 6, page 94.

14. If the bricks are laid flat, about 4 brick per sq. ft. will be required. For a walk 3 bricks wide, allow ½ cu. ft. sand, 2″ thick per ft. run of walk; 4 bricks wide, ⅝ cu. ft., 5 bricks wide, ¾ cu. ft.

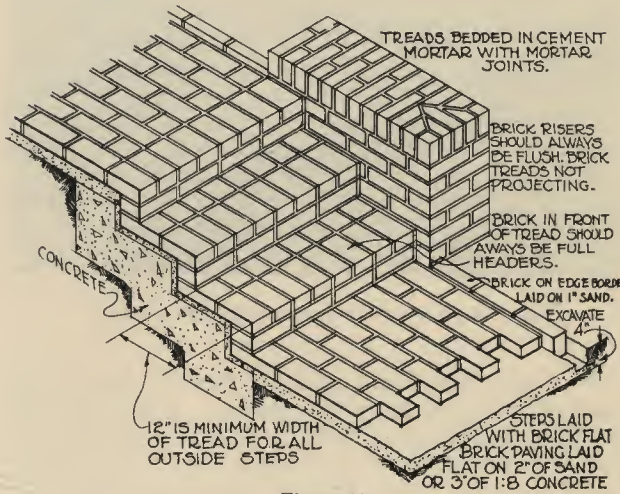


Figure 16.

Outside Steps:

15. These should always be laid on concrete. Treads should never be less than 12″ wide, or they may be dangerous when covered with ice and snow. Steps should pitch forward with a slope of about ¼″ per foot. The under surface of the concrete base should never slope, but be stepped off horizontally or the concrete will very likely slide out of place. The concrete should be thick enough to prevent it breaking. It may be reinforced if necessary. Figs. 15-16.

16. Joints in steps should always be filled with rich cement mortar, and pointed with a "thumb" joint, which is a broad slightly concave joint thoroughly rubbed with a steel jointing tool. The front of the treads should be laid of full length headers. Half bricks should not be used in this position. It is good practice to give the face of the brick to be

exposed a coat of raw linseed immediately before laying, as this prevents mortar sticking to the face of the brick and produces a clean job.

Garden Walls:

17. A brick wall is unexcelled either as a division wall or to shelter plants in certain exposures.

Figure 17. Beautiful curved garden wall, 4" thick.

18. Eight inch Ideal all-rolok walls or solid walls make charming walls for the garden. A straight wall should be thickened to form 12"x12" or 12"x16" piers at intervals of about 10-12 ft. according to the height, to add stability to the wall. Offsets or irregularities in the plan answer the same purpose. The wall should extend below the frost line, but no footing is required. Portland cement mortar should be used.

19. In the case of a wall dividing the same property into two or more parts, a wall 4" in thickness may be built as shown in Fig. 17, the curves in the plan of the wall giving it the necessary stability. The wall shown, 4 inches thick and about 8 feet high, has been standing over a century. It produces a variety of shady and sunny surfaces.

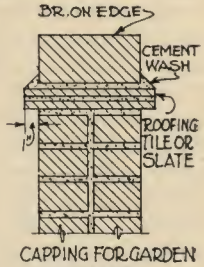


Figure 18

Capping Garden Walls:

20. The wall should be capped with a course of brick on edge in rich 1:2 Portland cement mortar. An artistic touch may be provided by placing two courses of slate or tile below the capping projecting about 1" on each side of the wall. (Fig. 18)

Pergola Posts; Gate Posts:

21. Hollow piers or posts, either of brick on edge or flat make sightly and permanent supports for the pergola roof. The brick on edge posts should not be more than 11"x11", the flat brick posts 12"x12". The interior may be left hollow. Footings should extend below frost line.

22. Gate posts and entrance posts may be built in the same manner, the gate being secured by bolts with anchor ends extending far enough into the post to take the strain, or passing entirely through the post with a plain or ornamental washer on the opposite side. Brickwork should be made solid and the pier large enough to stand the lateral strain of the gate. A charming effect may be secured by building a brick semi-circular arch over the gateway. There should be sufficient brickwork at the haunches to resist the thrust of the arch. Wrought iron gates, lamps, strapwork and other ornamental features are very effective when used in combination with brick.

BRICK IS BEST FOUNDATION FOR STUCCO

Stucco:

1. Stucco is plaster in various surface textures applied to exterior walls. In its natural state, however, cement finish is dreary and lifeless compared to the rich sparkling effects produced by exposing the brick.

2. A house finished in stucco placed upon a base of any construction cannot compete in price with the Ideal wall, with its beautiful everlasting brick surface; and in many localities the solid wall furred compares very favorably in price with the stucco house. It should be noted, however, that the price of the latter varies considerably according to the nature of the construction behind the stucco; and the fire-resistiveness and permanence of the underlying construction should always be carefully considered.

3. Inasmuch as the Economy, and after that the rolok-bak types of walls are the lowest in cost of any wall that can be constructed, it is suggested, if stucco finish appears desirable, to obtain bids upon this finish placed upon the types of walls mentioned, built with the lowest cost brick. Providing that all the headers, and the stretchers in the outer thickness, are fairly hard burned, even "cull" brick are entirely suitable for this purpose.

4. Stucco is a somewhat unreliable finish, however, inasmuch as its durability depends on the degree of its adhesion to its base, and there are many instances where stucco has disappointed owners by its tendency to peel away.

5. If a stucco finish is specially desired, a brick surface with joints left rough is far superior to any other building material yet devised as a base upon which to place it. The surface of the brick itself is of a nature that enables the stucco to bond into it, if well wet when the latter is applied, and if the joints are left rough a mechanical "key" is also provided, and brickwork, of course, never shrinks.

TABLES OF MATERIAL AND LABOR QUANTITIES FOR SOLID BRICKWORK

Example of Using Tables:

1. The following tables are designed to almost eliminate the calculations required to determine the amount of brick, mortar, laborers time, and bricklayers time for an ordinary building built with solid brickwork. Data on quantities of brick, mortar, and bricklayers' and laborers' time for Ideal and Economy walls is given in the sections of this book in which those types of wall are described. Table 7, page 95, will be found useful, however, in determining the quantity of materials required for the cubic footage of mortar required for Ideal and Economy walls.

2. To illustrate the use of these tables, figure the number of brick and materials required for mortar, laborer's and bricklayer's time required for 240 square feet of 8″ solid wall above grade in common bond, with cement-lime mortar. Referring to Table 4, page 93, the number of brick required for 200 square feet is 2,542, and for 40 square feet is 509; added together these equal 3,051 brick for the 240 square feet. The laborer's time for 200 square feet is 19 hours, and for 40 square feet is 4 hours, a total of 23 hours. Bricklayer's time for 200 feet is 17 hours and for 40 feet is 3½ hours, total 20½ hours. The mortar required equals 27 plus 5½ or 32½ cubic feet. Turning to Table 7, page 95, we find that 32½ cubic feet of cement-lime mortar requires 4.2 bags cement, 5 sacks hydrated lime, and 1.2 cubic yards of sand.

3. Add to the above any special items necessary, such as cost of foreman, if one is employed; rental of hoisting machinery and engineers time and fuel if job is large and such machinery used; special scaffolding, if such is necessary; cleaning down; mortar color; overhead expense and profit. (Par. 16.)

Estimates Based on Work of Experienced Men:

4. The time required to perform work is based on the average performance of experienced bricklayers and laborers. In some districts where bricklaying is done by men who are not so familiar with the work, the time allowance should be correspondingly increased.

Laborers Time:

5. Laborers time includes time for making and handling mortar, handling brick from pile on the ground, waiting on bricklayer, moving scaffold, etc. Laborers time for cleaning brickwork is not included in these tables and should be added if the brick wall surfaces are to be cleaned. (See par. 112, page 83.)

Bricklayers Time:

6. The figures in the tables which follow show the average number of brick laid on a small job in a country town. These figures can easily be increased through forethought and good management, so that each man may work with a clear cut job before him without making any waste motions.

7. On large work and in cities, bricklayers will lay 1500 brick per day on a solid wall, including facing and backing. Mr. Thos. R. Preece, formerly first vice-president of the Bricklayers, Masons, and Plasterers International Union, stated to the author that a bricklayer in Chicago who does not lay that amount every day could not hope to hold his job. The number of brick per day is figured in the tables far below the number quoted by Mr. Preece. Under good management there is no reason why these figures should not be equalled in any part of the country. The production of bricklayers now equals pre-war figures. Measure the work occasionally, and keep a record on every job you build.

8. Bricklayers time is calculated on the basis of work ordinarily required for the construction of an ordinary building under ordinary conditions. In case work has many special features, such as pilasters etc., or where special patterns must be formed on the surface of the wall or for cornice work, the bricklayers time should be increased according to the character of the work to be done. See also pars. 29-33, page 85, for time required to build chimneys and fireplaces.

Deducting Openings:

9. In figuring the area of a wall, deduct all openings, no matter how small. In making an allowance for the area of an opening, take the exact area of the masonry opening. This will give a little leeway in the case of double hung windows, for the recess occupied by the box is not deducted.

Simplicity of Figuring Brick:

10. There is only one way to safely estimate the cost of any kind of structure. That way is to figure each item carefully.

11. A brick house cannot be accurately figured by first estimating what the same house would cost in frame and then quoting almost offhand a higher price for brick. "Guess" systems do not make contractors prosperous in these days of competition and high efficiency. The contractor employing them is not prepared to meet competition because he never knows his exact costs. It is no harder to estimate a brick than a frame house. Every step in the process is very simple.

12. The data presented in the tables is absolutely reliable, and makes it possible for a contractor to arrive at the actual cost of the brick portion of a building at prices of material and labor which obtain at the moment in his own part of the country. The tables give the amount of material and labor necessary to perform the work. The actual cost can then be easily determined by local prices and wages.

Keep Records:

13. We suggest that the contractor keep his itemized estimates in a book, and follow them up by keeping careful records of the actual time and material consumed on each portion of every job. This will make future estimating much easier.

As Between Brick and Frame, Only Walls Above Foundation Vary in Cost:

14. The cost of the foundation and inside of the house—the joists, flooring, trim, wood partitions, chimneys, wiring, heating, roofing and interior finish—all these items show no variation, whether the house is of brick or frame.

15. The walls built of brick above the first floor line only will vary in cost and at present prices of brick, and with the increasing necessity for conserving lumber, there can be no question as to the economy and desirability of brick.

Don't Forget Contractor's "Overhead":

16. The contractor is reminded that the actual cost of the building consists not only of the cost of materials and labor, but must include a reasonable sum for overhead expense. Fire and accident or liability insurance, bond, general supervision, and office expense are some such items. The cost of materials and labor plus the "overhead" represents, therefore, the cost of the building to the contractor. The contractor's percentage of profit should be based upon and added to the total cost of materials, labor and overhead.

Number of Face Brick in Solid Walls:

17. The following data is issued by the American Face Brick association.

Number of Face Brick per Square Foot of Wall:

Joint	⅛"	¼"	⅜"	½"	⅝"	¾"
No. of brick	7½"	7 "	6½"	6⅛"	5¾"	5½"

18. The foregoing number of brick will be sufficient only for straight running bond, with no headers. It is apparent that an additional number of brick will be required for various bonds in proportion to the number of through headers used. The following percentages are therefore added to the number of face brick arrived at by the foregoing table.

Percentages Added to Number of Brick Given in par. 17 for Various Bonds.

Common (full header course every 5th course)........................20 % (⅕)

Common (full header course every 6th course)........................16⅔% (⅙)

Common (full header course every 7th course)........................14⅓% (1/7)

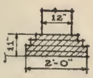
English or English Cross (full headers every 6th course)................16⅔% (⅙)

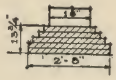
Flemish (full headers every 6th course). 5⅔% (1/18)

Double Header (two headers and a stretcher every 6th course)....... 8⅓% (1/12)

Double Header (two headers and a stretcher every 5th course)....... 10% (1/10)

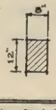
TABLE 1.—Brick footings ½" joints. Materials and labor for lengths in feet. Laborer's time includes mortar making. Cement mortar should be used. See Table 7 for material needed for cubic feet of mortar.





Length of Footing in Feet	8-INCH WALL					12-INCH WALL					16-INCH WALL					Length of Footing in Feet
	No. of Brick	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time, Hours: Lime or Cement-lime Mortar	Bricklayer's Approx. Time, Hours: Cement Mortar	No. of Brick	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time, Hours: Lime or Cement-lime Mortar	Bricklayer's Approx. Time, Hours: Cement Mortar	No. of Brick	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time, Hours: Lime or Cement-lime Mortar	Bricklayer's Approx. Time, Hours: Cement Mortar	
1	22.713	.385	.176	.129	.165	28.106	.477	.218	.160	.204	45.945	.780	.366	.230	.285	1
2	46	1	¼	¼	¼	57	1	½	¼	½	92	2	¾	½	¾	2
3	69	1½	½	½	½	85	1½	¾	½	½	138	2½	1	¾	1	3
4	91	2	¾	½	½	113	2	1	¾	¾	184	3½	1½	1	1¼	4
5	114	2	1	¾	¾	141	2½	1	¾	1	230	4	1¾	1¼	1½	5
6	137	2½	1	¾	1	169	3	1¼	1	1¼	276	5	2¼	1½	1¾	6
7	159	3	1¼	1	1¼	197	3½	1½	1¼	1½	322	5½	2½	1¾	2	7
8	182	3½	1½	1	1¼	225	4	1¾	1¼	1¾	368	6½	3	2	2¼	8
9	205	3½	1½	1¼	1½	253	4½	2	1½	1¾	414	7½	3¼	2¼	2½	9
10	228	4	1¾	1¼	1¾	282	5	2¼	1½	2	460	8	3¾	2½	3	10
20	455	8	3½	2½	3¼	563	10	4½	3¼	4	919	16	7¼	4¾	5¾	20
30	682	12	5¼	4	5	844	14½	6½	4¾	6	1378	24	11	7	8½	30
40	909	15	7	5¼	6½	1125	19	9	7	8	1837	31	15	9	11½	40
50	1136	20	9	7	8	1406	24	11	8	10	2296	39	18	12	14¼	50
100	2272	39	18	15	16	2812	48	22	16	20	4592	78	36	24	28½	100

TABLE 2.—Piers laid with ½" joints. All joints filled with mortar. Materials and labor for heights in feet. Laborer's time includes mortar making. See Table 7 for materials needed for cubic feet of mortar.



Height in Feet	8 x 12 Solid. Brick Laid Flat				12 x 12 Solid. Brick Laid Flat				12 x 16 Solid. Brick Laid Flat				10¾ x 10¾ Hollow. Brick Laid on Edge				Height in Feet
	No. Brick	Cu. Ft. Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	No. Brick	Cu. Ft Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	No. Brick	Cu. Ft. Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	No. Brick	Cu. Ft. Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	
1	12.320	.209	.096	.164	18.481	.313	.143	.246	24.641	.433	.192	.328	11.3	.088	.120	.180	1
2	25	½	¼	¼	37	¾	¼	½	50	1	½	¾	23	½	¼	½	2
3	37	¾	¼	½	56	1	½	¾	74	1½	½	1	34	½	½	½	3
4	50	1	½	¾	74	1½	½	1	99	1¾	¾	1¼	46	½	½	¾	4
5	62	1¼	½	¾	93	1¾	¾	1¼	124	2¼	1	1¾	57	½	½	1	5
6	74	1½	½	1	111	2	1	1½	148	2¾	1¼	2	68	½	¾	1	6
7	87	1½	¾	1¼	130	2¼	1	1¾	173	3¼	1½	2¼	80	½	1	1¼	7
8	99	1¾	¾	1¼	148	2¾	1¼	2	198	3½	1½	2¾	91	½	1	1½	8
9	111	2	1	1½	267	3	1¼	2¼	222	4	1¾	3	102	1	1	1¾	9
10	124	2¼	1	1¾	185	3¼	1½	2½	247	4½	2	3¼	113	1	1¼	2	10
20	247	4½	2	3¼	370	6½	3	4½	494	9	4	6½	226	2	2½	3¾	20

TABLE 3—Solid Exterior basement walls, ½" joints. Materials and labor for square foot areas.

Exterior 4" thickness of wall laid with all joints filled. Remaining brick laid on a full bed of mortar, but brick touching end to end. Vertical space between each 4" thickness filled with mortar. Every 5th course a header course. Laborer's time includes mortar making. Cement-lime mortar should generally be used for exterior basement walls. See Table 7 for materials needed for cubic feet of mortar. For weight of solid walls see page 9. For table of heights by courses see page 12.

Sq. Ft Area of Wall	8-INCH WALL No. of Bricks	8-INCH Cu. ft. of Mortar	8-INCH Laborer's Approx. Time, Hours	8-INCH Bricklayer's Approx. Time Hours: Lime or Cement-lime Mortar	8-INCH Bricklayer's Approx. Time Hours: Cement Mortar	12-INCH WALL No. of Bricks	12-INCH Cu. ft. of Mortar	12-INCH Laborer's Approx. Time, Hours	12-INCH Bricklayer's Approx. Time Hours: Lime or Cement-lime Mortar	12-INCH Bricklayer's Approx. Time Hours: Cement Mortar	16-INCH WALL No. of Bricks	16-INCH Cu. ft. of Mortar	16-INCH Laborer's Approx. Time, Hours	16-INCH Bricklayer's Approx. Time Hours: Lime or Cement-lime Mortar	16-INCH Bricklayer's Approx. Time Hours: Cement Mortar	Sq. Ft. Area of Wall
1	12.706	.195	.097	.073	.092	19.251	.314	.148	.110	.140	25.796	.433	199	.129	.159	1
10	128	2	1	¾	1	193	3½	1½	1	1½	258	4½	2	1½	2	10
20	255	4	2	1½	2	386	6½	3	2½	3	516	9	4	3	3½	20
30	382	6	3	2½	3	578	9½	4½	3½	4½	774	13	6	4	5	30
40	509	8	4	3	4	771	13	6	4½	6	1032	18	8	5½	6½	40
50	636	10	5	4	5	963	16	7½	5½	7	1290	22	10	6½	8	50
60	763	12	6	4½	5½	1156	19	9	7	9	1548	26	12	8	9½	60
70	890	14	7	5	6½	1348	22	11	8	10	1806	31	14	9	11½	70
80	1017	16	8	6	7	1541	25	12	9	11	2064	35	16	10½	13	80
90	1144	18	9	6½	8	1733	28	14	10	13	2322	39	18	12	14½	90
100	1271	20	10	7	9	1926	32	15	11	14	2580	44	20	13	16	100
200	2542	39	20	15	19	3851	63	30	22	28	5160	87	40	26	32	200
300	3812	59	29	22	28	5776	94	45	33	42	7740	130	60	39	48	300
400	5083	78	39	29	37	7701	126	60	44	56	10,319	173	80	52	64	400
500	6353	98	49	36	46	9626	157	74	55	70	12,899	217	100	65	80	500
600	7624	117	58	44	56	11,551	189	89	66	84	15,479	260	120	78	95	600
700	8895	137	68	51	65	13,476	220	104	77	98	18,058	303	140	90	111	700
800	10,165	156	78	58	74	15,402	251	120	88	112	20,638	347	160	103	127	800
900	11,436	175	87	66	83	17,327	283	134	99	126	23,218	390	180	116	143	900
1000	12,706	195	97	73	93	19,252	314	149	110	140	25,797	433	200	129	159	1000
2000	25,412	390	194	145	185	38,503	628	297	220	280	51,594	866	400	258	318	2000
3000	38,118	584	291	218	277	57,754	942	445	330	420	77,391	1299	599	387	477	3000
4000	50,824	779	388	291	370	77,006	1255	594	440	560	103,188	1732	799	516	636	4000
5000	63,530	973	485	363	462	96,257	1569	742	550	700	128,984	2165	999	645	795	5000
6000	76,236	1168	582	436	555	115,508	1883	890	660	840	154,781	2599	1199	774	954	6000
7000	88,942	1363	679	508	647	134,760	2197	1039	770	980	180,578	3032	1398	903	1113	7000
8000	101,648	1557	776	581	739	154,011	2511	1186	880	1120	206,375	3465	1598	1032	1272	8000
9000	114,353	1752	873	654	832	173,262	2825	1336	990	1260	232,172	3998	1798	1161	1431	9000
10000	127,059	1947	970	726	924	192,514	3139	1484	1100	1400	257,968	4331	1998	1290	1590	10000

TABLE 4—Solid exterior walls above grade in common bond ½" joints. Materials and labor for square foot areas. All joints in outside 4" thickness filled with mortar. Remaining brick laid on full bed of mortar but with brick touching end to end. Vertical space between each 4" thickness left open. Every 5th course a header course. Laborer's time includes mortar making. See Table 7 for materials needed for cubic feet of mortar. For weight of solid Walls see page 9. Page 12, gives heights by courses.

Sq. Ft. Area of Wall	8-INCH WALL No. of Bricks	8-INCH Cu. ft. of Mortar	8-INCH Laborer's Approx. Time Hours	8-INCH Bricklayer's Approx. Time Hours: Lime or Cement-Lime Mortar	8-INCH Bricklayer's Approx. Time Hours: Cement Mortar	12-INCH WALL No. of Bricks	12-INCH Cu. ft. of Mortar	12-INCH Laborer's Approx. Time Hours	12-INCH Bricklayer's Approx. Time Hours: Lime or Cement-Lime Mortar	12-INCH Bricklayer's Approx. Time Hours: Cement Mortar	16-INCH WALL No. of Bricks	16-INCH Cu. ft. of Mortar	16-INCH Laborer's Approx. Time Hours	16-INCH Bricklayer's Approx. Time Hours: Lime or Cement-Lime Mortar	16-INCH Bricklayer's Approx. Time Hours: Cement Mortar	Sq. Ft. Area of Wall
1	12.705	.135	.093	.084	.092	19.251	.194	.139	.128	.140	25.796	.254	.186	.137	172	1
10	128	1½	1	1	1	193	2	1½	1½	1½	258	3	2	1½	2	10
20	255	3	2	2	2	386	4	3	2½	3	516	5½	4	3	3½	20
30	382	4½	3	2½	3	578	6	4½	4	4	774	8	5½	4	5	30
40	509	5½	4	3½	4	771	8	5½	5½	5½	1032	10	8	5½	7	40
50	636	7	5	4	5	963	10	7	6½	7	1290	13	9	7	8½	50
60	763	8½	5½	5	5½	1156	12	9	8	8½	1548	16	11	8	10½	60
70	890	9½	6½	6	6½	1348	14	10	9	10	1806	18	13	9½	12	70
80	1,017	11	8	7	7½	1541	16	11	10½	11	2064	21	15	11	14	80
90	1,144	12	8½	7½	8	1733	18	13	12	12½	2322	23	17	12½	15½	90
100	1,271	14	9	8½	9	1926	20	14	13	14	2580	26	19	14	17	100
200	2,542	27	19	17	19	3851	39	28	26	28	5160	51	37	27	34	200
300	3,812	41	28	25	28	5776	42	42	38½	42	7740	77	56	41	52	300
400	5,083	54	37	34	37	7701	78	56	52	56	10,319	102	75	55	69	400
500	6,353	68	46	42	46	9626	98	70	64	70	12,899	127	93	69	86	500
600	7,624	81	56	50	56	11,551	117	84	77	84	15,479	153	112	82	103	600
700	8,895	95	65	59	65	13,476	137	98	90	98	18,058	178	131	96	120	700
800	10,165	108	74	67	74	15,402	156	112	102	112	20,638	204	149	110	138	800
900	11,436	122	84	76	83	17,327	176	126	115	126	23,218	229	168	123	155	9C0
1,000	12,706	135	93	84	93	19,252	195	140	128	140	25,797	255	187	137	172	1,000
2,000	25,412	270	185	168	185	38,503	399	279	256	280	51,594	509	373	274	344	2,000
3 000	38,118	406	278	252	277	57,754	585	419	384	420	77,391	764	560	411	516	3,000
4 000	50,824	541	371	336	370	77,006	779	558	512	560	103,188	1018	746	548	688	4,000
5,000	63,530	676	463	420	462	96,257	974	698	640	700	128,984	1272	933	685	860	5,000
6,000	76,236	811	556	504	555	115,508	1169	838	768	840	154,781	1527	1119	822	1032	6,000
7,000	88,942	946	648	588	647	134,760	1364	977	896	980	180,578	1781	1306	959	1204	7,000
8 000	101,648	1081	741	672	739	154,011	1558	1117	1024	1120	206,375	2036	1492	1096	1376	8,000
9,000	114,353	1216	834	756	832	173,262	1753	1256	1152	1260	232,172	2290	1679	1233	1548	9,000
10,000	127,059	1351	926	840	924	192,514	1948	1396	1280	1400	257,968	2545	1865	1370	1720	10,000

TABLE 5—Solid Exterior walls in Flemish, English, and English Cross Bonds, ½" joints. Materials and labor for square foot areas. Brick in outside 8" thickness laid ½" joints, with as many vertical joints parallel to the length of the wall left open as possible. Remaining brick in thicker walls laid on full mortar bed, but with brick touching end to end, and vertical space between each 4" thickness left open. Laborer's time includes mortar making. See Table 7 for material needed for cubic feet of mortar. For weight of solid walls see page 9. For table of heights by courses see page 12.

Sq. Ft. Area of Wall	8-INCH WALL					12-INCH WALL					16-INCH WALL					Sq. Ft. Area of Wall
				Bricklayer's Approx. Time Hours					Bricklayer's Approx. Time Hours					Bricklayer's Approx. Time Hours		
	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time, Hours	Lime or Cement-lime Mortar	Cement Mortar	No. of Bricks	Cu. ft of Mortar	Laborer's Approx. Time, Hours	Lime or Cement-lime Mortar	Cement Mortar	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time, Hours	Lime or Cement-lime Mortar	Cement Mortar	
1	12 320	.195	095	104	109	18 866	254	141	158	167	25.411	.313	.188	.179	197	1
10	124	2	1	1	1	189	3	1½	1½	2	255	3½	2	2	2	10
20	247	4	2	2	2½	378	5½	3	3½	3½	509	6½	4	3½	4	20
30	370	6	3	3½	3½	566	8	4½	5	5	763	9½	6	5½	6	30
40	493	8	4	4½	4½	755	10½	6	6½	7	1017	13	8	7½	8	40
50	617	10	5	5½	5½	944	13	7	8	8½	1271	16	10	9	10	50
60	740	12	6	6½	6½	1132	16	9	10	10	1525	19	11	11	12	60
70	863	14	7	7½	8	1321	18	10	11	12	1779	22	13	13	14	70
80	986	16	7½	8½	9	1510	21	12	13	14	2033	25	15	15	16	80
90	1109	18	9	10	10	1698	23	13	14	15	2288	29	17	17	18	90
100	1233	20	10	11	11	1887	26	14	16	17	2542	32	19	18	20	100
200	2465	39	19	21	22	3774	51	28	32	34	5083	63	38	36	39	200
300	3697	59	29	31	33	5660	77	43	48	51	7624	94	57	54	59	300
400	4929	78	38	42	44	7547	102	57	64	67	10,165	126	76	72	79	400
500	6161	98	47	52	55	9434	127	71	80	84	12,706	157	94	90	99	500
600	7393	117	57	62	66	11,320	153	85	96	101	15,248	189	113	108	118	600
700	8625	137	66	73	77	13,207	178	99	111	118	17,789	220	132	126	138	700
800	9857	156	76	83	88	15,094	204	113	127	134	20,330	251	151	144	158	800
900	11,089	175	85	94	99	16,980	229	128	143	151	22,871	283	170	161	177	900
1000	12,321	195	95	104	110	18,867	255	142	159	168	25,412	314	189	179	197	1000
2000	24,642	390	189	208	219	37,733	509	283	318	336	50,824	628	377	359	394	2000
3000	36,963	584	284	311	329	56,599	763	425	477	503	76,236	942	565	538	591	3000
4000	49,284	779	378	415	438	75,466	1017	566	636	671	101,648	1256	754	717	788	4000
5000	61,605	973	473	519	548	94,332	1272	708	795	839	127,059	1570	942	896	955	5000
6000	73,926	1168	567	623	757	113,198	1526	849	953	1006	152,471	1884	1131	1075	1182	6000
7000	86,247	1363	662	726	767	132,065	1780	990	1112	1174	177,883	2198	1319	1255	1379	7000
8000	98,567	1557	756	830	876	150,931	2035	1132	1271	1342	203,295	2512	1508	1434	1576	8000
9000	110,888	1752	851	934	986	169,797	2289	1273	1430	1510	228,706	2826	1696	1613	1773	9000
10000	123,209	1947	945	1038	1095	188,664	2543	1415	1589	1677	154,118	3140	1885	1790	1970	10000

TABLE 6—Solid Walls in all bonds with ½" joints, all joints filled with mortar. Materials and labor for square foot areas. "Other bonds" includes Flemish, English, and English Cross bonds. Laborer's time includes mortar making. See Table 7 for material needed for cubic feet of mortar. For weight of solid walls see page 9. Page 12, gives heights by courses.

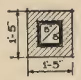
Sq. Ft. Area of Wall	4-INCH WALL				8-INCH WALL						
								Bricklayer's Approx. Time, Hours Common Bond		Other Bonds	
	No. of Bricks	Cu. ft. of Mortar	Labor-er's Approx. Time Hours	Brick-layer's Approx. Time Hours	No. of Bricks	Cu. ft. of Mortar	Labor-er's Approx. Time Hours	Lime or Cement-lime Mortar	Cement Mortar	Lime or Cement-lime Mortar	Cement Mortar
1	6 160	075	045	062	12 320	195	095	090	099	104	109
10	62	1	½	¾	124	2	1	1	1	1	1
20	124	2	1	1½	247	4	2	2	2	2	2½
30	185	2½	1½	2	370	6	3	3	3	3½	3½
40	247	3½	2	2½	493	8	4	3½	4	4½	4½
50	309	4	2½	3½	617	10	5	4½	5	5½	5½
60	370	5	3	4	740	12	6	5½	6	6½	6½
70	432	5½	3½	4½	863	14	7	6½	7	7½	8
80	493	6½	4	5	986	16	7½	7½	8	8½	9
90	555	7	4½	5½	1,109	18	9	8	9	10	10
100	617	8	5	6½	1,233	20	10	9	10	11	11
200	1,233	15	9	13	2,465	39	19	18	20	21	22
300	1,849	23	14	19	3,697	59	29	27	30	31	33
400	2,465	30	18	25	4,929	78	38	36	40	42	44
500	3,081	38	23	31	6,161	98	47	45	49	52	55
600	3,697	46	28	37	7,393	117	57	54	59	62	66
700	4,313	53	32	43	8,625	137	66	69	69	73	77
800	4,929	61	37	49	9,857	156	76	72	79	83	88
900	5,545	68	41	56	11,089	175	85	81	89	94	99
1,000	6,161	76	46	62	12,321	195	95	90	99	104	110
2,000	12,321	151	91	123	24,642	390	189	179	197	208	219
3,000	18,482	227	137	185	36,963	584	284	269	296	311	329
4,000	24,642	302	183	247	49,284	779	378	359	394	415	438
5,000	30,803	377	228	308	61,605	973	473	448	493	519	548
6.000	36,963	453	274	370	73,926	1168	567	538	592	623	657
7.000	43,124	528	320	431	86,247	1363	662	627	690	726	767
8.000	49,284	604	365	493	98,567	1557	756	717	789	830	876
9.000	55,444	679	411	555	110,888	1752	851	807	887	934	986
10,000	61,605	755	457	616	123,209	1947	945	896	986	1038	1095

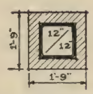
12 INCH WALL							16-INCH WALL							Sq. Ft. Area of Wall
			Bricklayer's Approx. Time. Hours Common Bond		Other Bonds					Bricklayer's Approx. Time, Hours Common Bond		Other Bonds		
No. of Bricks	Cu ft of Mortar	Labor-er's Approx. Time Hours	Lime or Cement-Lime Mortar	Cement Mortar	Lime or Cement-lime Mortar	Cement Mortar	No of Bricks	Cu ft of Mortar	Labor-er's Approx. Time Hours	Lime or Cement-lime Mortar	Cement Mortar	Lime or Cement-lime Mortar	Cement Mortar	
18 481	314	.143	134	148	156	164	24 641	433	192	152	179	179	197	1
185	3½	1½	1½	1½	½	2	247	4½	2	1½	2	2	2	10
370	6½	3	3	3	3½	3½	493	9	4	3	3½	3½	4	20
555	9½	4½	4	4½	5	5	740	13	6	4½	5½	5½	6	30
740	13	6	5½	6	6½	6½	986	17½	8	6	7½	7½	8	50
925	16	7½	7	7½	8	8½	1,233	22	10	8	9	9	10	50
1,109	19	9	8	9	9	10	1,179	26	12	9	11	11	12	60
1,294	22	10	10	11	11	12	1,725	31	14	11	13	13	14	70
1,479	25	12	11	12	13	13	1,972	35	16	12	15	15	16	80
1,664	28	13	12	13	14	15	2,218	39	17	14	17	17	18	90
1,849	32	15	14	15	16	17	2,465	44	19	15	18	18	20	100
3,697	63	29	27	30	31	33	4,929	87	39	30	36	36	39	200
5,545	94	43	41	45	47	49	7,393	130	58	46	54	54	59	300
7,393	126	58	54	59	62	66	9,857	173	77	61	72	72	79	400
9,241	157	72	67	74	78	82	12,321	217	96	76	90	90	99	500
11,089	189	86	81	89	94	99	14,786	260	116	91	108	108	118	600
12,937	220	101	94	104	109	115	17,250	303	135	106	125	125	138	700
14,786	251	115	108	118	124	131	19,714	347	154	122	143	143	158	800
16,634	283	129	121	133	140	148	22,178	390	173	137	161	161	177	900
18,482	314	144	135	148	156	164	24,642	433	192	152	179	179	197	1,000
36,963	628	287	269	296	311	328	49,284	866	385	304	359	359	394	2,000
55,444	942	430	403	444	467	492	73,926	1299	577	451	538	538	591	3,000
73,926	1255	574	538	592	623	657	98,567	1732	769	608	717	717	788	4,000
92,407	1569	717	672	739	778	721	123,209	2165	961	760	896	896	985	5,000
110,888	1883	860	807	887	934	985	147,851	2599	1154	912	1075	1075	1182	6,000
129,370	2197	1004	941	1035	1090	1149	172,493	3032	1346	1064	1255	1255	1379	7,000
147,851	2511	1147	1075	1183	1245	1313	197,124	3465	1538	1216	1434	1434	1576	8,000
166,332	2825	1291	1210	1331	1401	1478	221,776	3898	1730	1368	1613	1613	1773	9,000
184,813	3139	1434	1344	1479	1557	1643	246,418	4331	1923	1520	1792	1792	1970	10,000

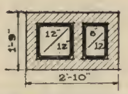
TABLE 7—Quantities of Material for Cubic Feet of Mortar Found in Other Tables. Quantities of lime are based on the use of good quality lime. Lime quantities are approximate and will vary with the grade of lime and the size of particles composing the sand. In the cement mortars, 1/10 of the cement by weight is replaced by dry hydrated lime or its equivalent in lump lime paste.

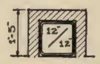
Cu. Ft. Mortar	LIME MORTAR 1:2½ 180 lb. Bbls. Lump Lime or 50 lb. Sacks Hydrated Lime	LIME MORTAR 1:2½ Cu. Yds. Sand	LIME MORTAR 1:3 180 lb. Bbls. Lump Lime or 50 lb. Sacks Hydrated Lime	LIME MORTAR 1:3 Cu. Yds. Sand	CEMENT-LIME MORTAR 1:1:6 94 lbs. Net Sacks Cement	CEMENT-LIME MORTAR 1:1:6 180 lb. Bbls. Lump Lime or 50 lb. Sacks Hydrated Lime	CEMENT-LIME MORTAR 1:1:6 Cu. Yds. Sand	CEMENT MORTAR 1:2 94 lb. Net Sacks Cement	CEMENT MORTAR 1:2 180 lb. Bbls. Lump Lime or 50 lb. Sacks Hydrated Lime	CEMENT MORTAR 1:2 Cu. Yds. Sand	CEMENT MORTAR 1:3 94 lb. Net Sacks Cement	CEMENT MORTAR 1:3 180 lb. Bbls. Lump Lime or 50 lb. Sacks Hydrated Lime	CEMENT MORTAR 1:3 Cu. Yds. Sand	CEMENT MORTAR 1:4 94 lb. Net Sacks Cement	CEMENT MORTAR 1:4 180 lb. Bbls. Lump Lime or 50 lb. Sacks Hydrated Lime	CEMENT MORTAR 1:4 Cu. Yds. Sand	Cu. Ft. Mortar
1	.057 or .350	.037	.1 or .3	037	.129	023 or .145	.037	.4	.1 or 1	1	3	1 or .1	1	.3	.1 or .1	.1	1
2	.1 or .7	.1	.1 or .6	.1	.3	.1 or .3	.1	.9	.1 or 2	1	7	1 or .1	1	.5	.1 or .1	.1	2
3	.2 or 1.1	1	.1 or .9	.1	.4	.1 or .4	.1	1 3	1 or .3	1	1 0	1 or .2	1	.8	.1 or .2	.1	3
4	.2 or 1.4	1	.2 or 1.2	1	.5	.1 or .6	.1	1 8	1 or 4	1	1.3	1 or .3	2	1.1	.1 or .2	.2	4
5	.3 or 1.8	2	2 or 1.5	2	.6	.1 or .7	2	2 2	1 or .5	2	1 7	1 or 3	2	1.3	.1 or .3	.2	5
6	.3 or 2.1	2	.3 or 1.8	2	.8	.1 or .9	2	2 7	.1 or 6	.2	2.0	.1 or .4	2	1.6	.1 or .3	2	6
7	.4 or 2.5	3	3 or 2.0	3	.9	.2 or 1.0	3	3.1	.1 or 6	.2	2.3	.1 or .5	3	1.8	.1 or .4	3	7
8	.5 or 2.8	.3	4 or 2.3	3	1.0	.2 or 1.2	3	3 5	.1 or .7	3	2.6	.1 or 6	3	2.1	.1 or 4	3	8
9	.5 or 3.2	.3	4 or 2.6	:3	1.2	.2 or 1.3	3	3.9	.1 or .8	.3	3.0	.1 or .6	3	2.4	.1 or .5	4	9
10	.6 or 3.5	.4	.5 or 2.9	4	1 3	.2 or 1.5	4	4.4	2 or .9	3	3.3	1 or 7	4	2.6	.1 or .6	4	10
11	.7 or 3.9	.4	.5 or 3 2	4	1 4	.3 or 1.6	4	4.9	2 or 1.0	.4	3.6	1 or 8	4	2.9	.1 or .6	5	11
12	.7 or 4.2	4	.6 or 3.5	4	1.6	.3 or 1.7	.4	5.3	2 or 1 1	4	4.0	1 or 8	5	3.2	.1 or .7	5	12
13	.7 or 4.6	.5	6 or 3.8	5	1.7	.3 or 1.9	5	5.7	.2 or 1.2	.4	4.3	2 or 9	5	3.4	1 or .7	5	13
14	.8 or 4.9	.5	.7 or 4 1	5	1.8	.3 or 2.0	.5	6.2	.2 or 1.3	5	4.6	2 or .9	5	3.7	.1 or .8	6	14
15	.9 or 5.3	.6	.7 or 4.4	6	1.9	.4 or 2.2	.6	6.6	.2 or 1.4	.5	5.0	2 or 1 0	6	4.0	2 or 8	6	15
16	.9 or 5.6	.6	.8 or 4.7	6	2.1	.4 or 2.3	.6	7.1	3 or 1.5	5	5.3	2 or 1.1	6	4.2	2 or 9	7	16
17	1.0 or 6.0	.6	.8 or 5 0	6	2.2	4 or 2.5	.6	7.5	3 or 1.6	.6	5.6	2 or 1.2	7	4.6	2 or 9	7	17
18	1.0 or 6.3	.7	.9 or 5.3	7	2 3	.4 or 2.6	.7	8.0	3 or 1.7	.6	6 0	.2 or 1.2	7	4.8	2 or 1.0	7	18
19	1.1 or 6.7	.7	.9 or 5 5	7	2.5	.5 or 2.8	.7	8.4	3 or 1.8	.6	6 3	2 or 1.3	.7	5.0	2 or 1.0	8	19
20	1.1 or 7.0	.7	.9 or 5.8	7	2.6	.5 or 2.9	.7	8.9	.3 or 1.8	.7	6 6	.2 or 1.4	8	5.3	2 or 1.1	8	20
27	1.5 or 9.5	1.0	1.3 or 7.8	1.	3.50	.64 or 3.94	1.0	12.0	.4 or 2.5	9	8 9	.3 or 1.9	1.1	7.1	3 or 1.5	1 1	27
30	1.7 or 10.5	1.1	1.4 or 8.7	1.1	3.8	7 or 4.4	1 1	13.3	.5 or 2.8	1.0	9.9	4 or 2.1	1 2	7.9	.3 or 1.7	1.2	30
40	2.3 or 14.0	1 5	1.9 or 11.7	1 5	5.2	.9 or 5.8	1 5	17 7	.7 or 3.7	1.3	13.2	5 or 2 8	1 6	10.6	.4 or 2 2	1.6	40
50	2.8 or 17.5	1.9	2.4 or 14.6	1 9	6 5	1 2 or 7.3	1 9	22 1	8 or 4.6	1.7	16.5	6 or 3 5	1.9	13.2	5 or 2.8	2.1	50
60	3.4 or 21.0	2.2	2.8 or 17.5	2.2	7 8	1 4 or 8.8	2•2	26 6	1 0 oı 5.5	2.1	19.8	7 or 4.1	2.3	15.8	6 or 3 3	2 5	60
70	3.9 or 24.5	2.6	3.3 or 20.4	2.6	9.1	1 7 or 10.2	2 6	31 0	1 1 or 6.5	2.4	23.1	9 or 4.8	2.7	18.5	7 or 3 9	2 9	70
80	4.6 or 28.0	3.0	3.8 or 23.3	3 0	10 4	1.9 or 11.7	3.0	35 4	1 3 or 7.4	2.8	26.4	2.0 or 5.5	3.1	21.1	8 or 4.4	3 3	80
90	5.1 or 31.5	3.3	4.3 or 26.3	3.3	11 7	2.1 or 13.1	3.3	39.8	1 5 or 8.3	3.1	29.8	1.1 or 6.2	3.5	23.8	9 or 5.0	3.7	90
100	6 or 35	4	5 or 29	4	13	2 or 15	4	44	2 or 9	3	33	1.2 or 7	4	26	1 or 6	4	100
200	11 or 70	7	9 or 58	7	26	5 or 29	7	88	3 or 18	7	66	2 or 14	8	53	2 or 11	8	200
300	17 or 105	11	14 or 88	11	39	7 or 44	11	132	5 or 28	10	99	4 or 21	12	79	3 or 17	12	300
400	23 or 140	15	19 or 117	15	52	10 or 58	15	177	7 or 37	14	132	5 or 28	16	106	4 or 22	16	400
500	29 or 175	19	24 or 146	19	65	12 or 73	19	221	8 or 46	17	165	6 or 35	19	132	5 or 28	21	500
600	34 or 210	22	28 or 175	22	78	14 or 88	22	265	10 or 55	21	198	7 or 41	23	158	6 or 33	25	600
700	40 or 245	26	33 or 204	26	91	17 or 102	26	310	11 or 65	24	231	9 or 48	27	184	7 or 39	29	700
800	46 or 280	30	38 or 233	30	104	19 or 117	30	354	13 or 74	28	265	10 or 55	31	211	8 or 44	33	800
900	51 or 315	33	43 or 263	33	117	21 or 131	33	398	15 or 83	31	298	11 or 62	35	238	9 or 50	37	900
1000	57 or 350	37	47 or 292	37	130	24 or 146	37	442	16 or 92	34	331	12 or 69	39	264	10 or 55	41	1000
2000	114 or 700	74	95 or 584	74	259	47 or 292	74	885	33 or 185	68	661	24 or 138	78	528	20 or 110	82	2000
3000	171 or 1050	111	142 or 876	111	389	71 or 438	111	1328	49 or 277	103	992	37 or 207	117	792	29 or 165	123	3000
4000	228 or 1400	148	190 or 1167	148	518	95 or 584	148	1771	65 or 370	138	1322	49 or 276	156	1056	39 or 221	164	4000
5000	285 or 1750	185	237 or 1459	185	648	119 or 730	185	2214	82 or 462	172	1654	61 or 345	194	1320	49 or 276	206	5000

TABLE 8—Flues laid with ½" joints. All joints filled with mortar. Material and labor for heights in feet. Laborer's time includes mortar making. See Table 7 for material needed for cubic feet of mortar.
NOTE:—These tables may be used for almost any one and two flue chimneys, as the variations from these figures would be slight, no matter the size of the flues.









Height in Feet	8 x 8 FLUE No of Bricks	8 x 8 FLUE Cu. ft. of Mortar	8 x 8 FLUE Laborer's Approx. Time Hours	8 x 8 FLUE Bricklayer's Approx. Time Hours	12 x 12 FLUE No. of Bricks	12 x 12 FLUE Cu. ft. of Mortar	12 x 12 FLUE Laborer's Approx Time Hours	12 x 12 FLUE Bricklayer's Approx. Time Hours	12 x 12 and 8 x 12 FLUES No. of Bricks	12 x 12 and 8 x 12 FLUES Cu. ft. of Mortar	12 x 12 and 8 x 12 FLUES Laborer's Approx. Time Hours	12 x 12 and 8 x 12 FLUES Bricklayer's Approx. Time Hours	8 x 8 FLUE No. of Bricks	8 x 8 FLUE Cu. ft. of Mortar	8 x 8 FLUE Laborer's Approx. Time Hours	8 x 8 FLUE Bricklayer's Approx. Time Hours	12 x 12 FLUE No. of Bricks	12 x 12 FLUE Cu. ft. of Mortar	12 x 12 FLUE Laborer's Approx Time Hours	12 x 12 FLUE Bricklayer's Approx. Time Hours	12 x 12 and 8 x 12 FLUES No. of Bricks	12 x 12 and 8 x 12 FLUES Cu. ft. of Mortar	12 x 12 and 8 x 12 FLUES Laborer's Approx. Time Hours	12 x 12 and 8 x 12 FLUES Bricklayer's Approx. Time Hours	Height in Feet
1	25.873	.433	200	.344	34.498	.577	267	.459	53.895	810	410	.718	17.249	.288	133	.229	23.717	.396	.183	.316	36.652	613	.283	.488	1
2	52	1	½	¾	69	1½	½	1	108	2	1	1½	35	1	¼	½	48	1	½	¾	74	1½	½	1	2
3	78	1½	¾	1	104	2	¾	1½	162	2½	4¼	2¼	52	1	½	¾	72	1½	½	1	110	2	¾	1½	3
4	104	2	¾	1½	138	2½	1	1¾	216	3½	1¾	3	69	1½	½	1	95	2	¾	1¼	147	2½	1¼	2	4
5	130	2½	1	1¾	173	3	1¼	2¼	270	4½	2	3½	87	1½	¾	1¼	119	2	1	1½	184	3½	1½	2½	5
6	156	3	1¼	2	207	3½	1½	2¾	324	5	2½	4¼	104	2	¾	1½	143	2½	1	1	220	4	1¾	3	6
7	182	3½	1½	2½	242	4½	1¾	3¼	378	6	3	5	121	2½	1	1½	166	3	1¼	2¼	257	4½	2	3½	7
8	207	3½	1½	2¾	276	5	2¼	3¾	432	6½	3¼	5¾	138	2½	1	1¾	190	3½	1½	2½	294	5	2¼	4	8
9	233	4	1¾	3	311	5½	2½	4¼	486	7½	3½	6½	156	3	1¼	2	214	4	1¾	3	330	6	2½	4½	9
10	259	4½	2	3½	345	6	2¾	4½	539	8½	4	7¼	173	3	1½	2¼	238	4	1¾	3¼	367	6½	2¾	5	10
15	389	6½	3	5¼	552	9	4	7	809	12½	6	10¾	259	4½	2	3½	356	6	2¾	4¾	550	9½	4¼	7¼	15
20	518	9	4	7	690	12	5½	9¼	1078	16½	8	15	345	6	2¾	4½	475	8	3¾	6¼	734	12½	5¾	9¾	20
25	647	11	5	8½	863	14½	6¾	11½	1348	21	10	18	432	7½	3½	6	593	10	4½	8	917	15½	7	12¼	25

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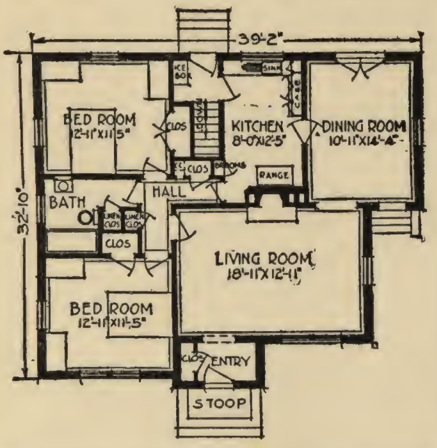

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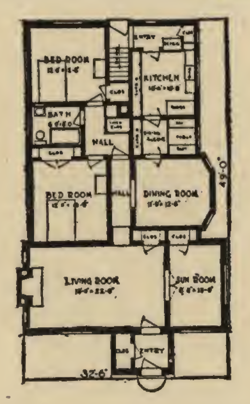

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